REVIEW

MISSION OPERATIONS AND DATA SYSTEMS DIRECTORATE

Landsat 7

Image Assessment System (IAS)

Critical Design Specification

Volume 1

April 1997

National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

REVIEW

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Critical Design Specification
Volume 1

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Preface

This critical design specification contains the detail level design information for the IAS. The IAS critical design is based on an analysis of the requirements contained in the IAS Elemental Specification, the associated Interface Control Documents, the System Specification, the Preliminary Design Specification and results of various technical analyses performed by the IAS Project. This IAS Critical Design Specification, once baselined at/after the Critical Design Review (CDR), will be controlled by the IAS/LPGS Project Management Control Board (PMCB) and maintained and updated, as required, by the IAS Project. Volume 1 excludes the design material for the Geometric Processing Subsystem.

This critical design specification was prepared for:

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Abstract

The Landsat 7 Image Assessment System (IAS) provides the Landsat 7 Program with the capability to assess the quality of the Level 0R datasets being distributed to users by the Earth Resources Observation System (EROS) Data Center (EDC) Distributed Active Archive Center (DAAC) and to calibrate the on-orbit radiometry and geometry of the Landsat 7 Enhanced Thematic Mapper + (ETM+) instrument and satellite. The IAS receives Level 0R products from the EDC DAAC and processes them to Level 1G. Data from onboard calibration sources and special geometric test site scenes are processed to revise calibration (correction and registration) parameters. The resulting parameters are provided to the EDC DAAC for generation of Level 1 products and for distribution to users ordering Level 0R ETM+ data. The system design presented in this document is based on the requirements contained in the IAS Element Specification and associated Interface Control Documents.

Keywords: *Landsat 7 Image Assessment System (IAS), Geometric calibration, Radiometric calibration, Evaluation and assessment, EDC Distributed Active Archive Center (DAAC)*

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Section 1. Introduction

1.1 Purpose

This document describes the critical design for the Landsat 7 Image Assessment System (IAS) that will be used to support the implementation of the system.

1.2 Scope

This document includes the functional system overview, system design methodology and operational scenarios, software design overview, subsystem design, database design, user interface design, and hardware usage of the IAS. Appendix A contains the Requirements Traceability Table that identifies the requirements for IAS and their traceability to the design.

This document, Volume 1, excludes the critical design for the Geometric Processing Subsystem.

1.3 Applicable Documents

The following documents contain additional details regarding the IAS, the Landsat 7 System and Project, and external systems.

1.3.1 Requirements Impact Documents

The following documents contain requirements that impact the IAS design.

1. National Aeronautics and Space Administration (NASA), Goddard Space Flight Center (GSFC), 430-15-01-001-0, *Landsat-7 Image Assessment System (IAS) Element Specification*, October 1996.

2. NASA/GSFC, 430-11-06-007-0, *Landsat 7 0R Distribution Product Data Format Control Book HDF Version*, July 2, 1996 Review Draft.

3. NASA/GSFC, 430-15-01-002-0, *Landsat 7 Calibration Parameter File Definition*.

4. NASA/GSFC, 430-L-0002-H, *Landsat 7 System Specification*, August 1994.

5. Computer Sciences Corporation (CSC), *Landsat-7 Mission operations Center (MOC) to Image Assessment System (IAS) Interface Control Document (ICD*), November 1995.

6. NASA/GSFC, 514-11CD/0195, *Interface Control Document (ICD) Between the Image Assessment System (IAS) and the Landsat-7 Processing System (LPS*), January 31, 1996.

7. TBS, **IAS-LPGS ICD**, *Interface Control Document (ICD) Between the Image Assessment System (IAS) and the Level 1 Product Generation System (LPGS)* - Working Draft, January 29, 1997

8. Hughes Information Technology Systems, 209-CD-013-003, *Interface Control Document Between EOSDIS Core System (ECS) and the Landsat-7 System*, March 1996.

9. CSC, *Landsat-7 Image Assessment System (IAS) System Design Specification, December 1996.*

10. CSC, *Landsat-7 Image Assessment System (IAS) Preliminary System Design,* December 1996.

11. CSC, *Systems, Engineering, and Analysis Support (SEAS) System Development Methodology (SSDM), Release 2,* December 1993

12. CSC, *SEAS System Development Methodology SSDM Standards and Procedures,* August 1994

1.3.2 Reference Documents

The following documents contain additional background information related to the Landsat 7 mission and to the IAS.

1. NASA, *Landsat 7 Level I Requirements*, Draft Issue, August 8, 1994.

2. Allied-Signal Technical Services Corporation, *Landsat 7 Detailed Mission Requirements,* March 1996.

3. Martin Marietta Astro Space (MMAS), *Landsat-7 System Image Assessment System Operations Concept*, September 1994.

4. NASA GSFC, 430-11-06--003-0, *Landsat 7 System and Operations Concept*, October 1994.

5. MMAS, CDRL No. A104, *Space Segment Calibration Plan*, August 1994.

6. MMAS 23007702, *Landsat 7 System Data Format Control Book (DFCB) Volume 4 - Wideband Data*, December 2, 1994.

7. MMAS, CDRL #A058, 23007610A, *Landsat-7 Program Coordinate System Standard, Rev. B*, December 1994.

8. United States Geological Survey (USGS)/National Oceanic and Atmospheric Administration (NOAA), *Index to Landsat 7 Worldwide Reference System (WRS*), 1982.

9. EROS Data Center, *Landsat 7 Image Assessment System Geometric Processing Subsystem Detailed Design Specification*, March 1997 [Volume 2 of Landsat 7 Image Assessment System (IAS) Critical Design Specification]

1.4 Definitions of Acronyms

The List of Acronyms, located after the appendixes in this document, contains the acronyms with their meanings. These acronyms are from requirements, this document, and other applicable documents.

1.5 Documentation Organization

The remainder of this document contains 13 sections and two (2) appendixes. The following paragraphs describe the rest of the document.

Section 2, <u>System Overview</u>, contains general definitions; information about external interfaces, hardware, and software; and a description of the functional capabilities of the IAS.

Section 3, <u>Design Overview</u>, identifies the methods and considerations used to design the system, as well as high level descriptions of the system and its subsystems.

Section 4, <u>Operational Scenarios</u>, provides descriptions of operational activities as they interact with the IAS to fulfill specific tasks.

Section 5, <u>Global Library</u>, describes the major sections of the global library and lists the global routines.

Sections 6 through 10 present the top-level design of the IAS subsystems. For each subsystem, there is an introduction, a design overview with a context diagram, a subsystem design that identifies main tasks within the subsystem, and the identification of internal files. For each main task, there is a purpose; assumption(s); and information on initialization, normal operation, and error handling; and a design. The design includes a structure chart; defines input, output, and the task flow using program design language (PDL); and includes a table that identifies the units unique to the task.

Section 11, <u>Data Base</u>, presents the design of the IAS database and the method used in designing the database.

Section 12, User Interface, presents a description of the IAS user interface (UI) and the method and tools used to design the interface. It also describes the commercial-off-the-shelf systems (COTS) used to facilitate UI.

Appendix A contains the Requirements Traceability Table. Appendix B presents the Estimated Lines of Code needed to implement the IAS. Appendix C presents the Radiometric Algorithms and their process sequence. Appendix D presents the definitions of the IAS database entitites and Appendix E presents the contents of the MMO reports.

Section 2. System Overview

This section provides an overview of IAS that includes its background, functional responsibilities, high-level operations concept, and general definitions. It also identifies the external interfaces, hardware, software, and functional capabilities that IAS requires to fulfill its requirements.

2.1 Landsat 7 General Overview

IAS is an element of the Landsat 7 Ground Handling Segment. It has the responsibility for off-line assessment of image quality. The off-line assessment of image quality ensures compliance with the radiometric and geometric requirements of the spacecraft and the Enhanced Thematic Mapper Plus (ETM+) sensor throughout the life of the Landsat 7 mission.

In addition to its assessment functions, the IAS is also responsible for the radiometric and geometric calibration of Landsat 7 satellite and ETM+. The IAS will be located at the Earth Resources Observation System (EROS) Data Center (EDC) in Sioux Falls, South Dakota to support the Landsat 7 satellite mission.

2.1.1 Background

The Landsat 7 satellite mission is a joint NASA, National Oceanic and Atmospheric Administration (NOAA), and United States Geological Survey (USGS) program. It will provide a wide-area multispectral imaging capability serving the global change research, national security, civil, and private sector users. The scheduled launch of Landsat 7 is 1998 with a planned operational life of 5 years. The Landsat 7 satellite provides payload data to a Landsat Ground Segment (LGS) in Sioux Falls, South Dakota and a collection of International Ground Stations (IGSs).

2.1.2 High-Level Operations Concept

The IAS interfaces with the EDC Distributed Active Archive Center (EDC DAAC), Landsat 7 Processing (LP) System (LPS), Mission Operations Center (MOC), Level 1 Product Generation System (LPGS), and the Mission Management Office (MMO). The IAS Context Diagram, figure 2-1, shows the external interfaces to the IAS.

When the EDC DAAC has new holdings that need assessment, an operator places an order requesting a specific Level 0R (L0R) product from the EDC DAAC and submits a processing request to IAS. The EDC DAAC responds to the order by providing the appropriate L0R to the IAS. Upon detection, the IAS ingests the L0R and schedules the product for assessment.

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The IAS assesses image data in raw form and processes the data to Level 1R and 1G for assessment

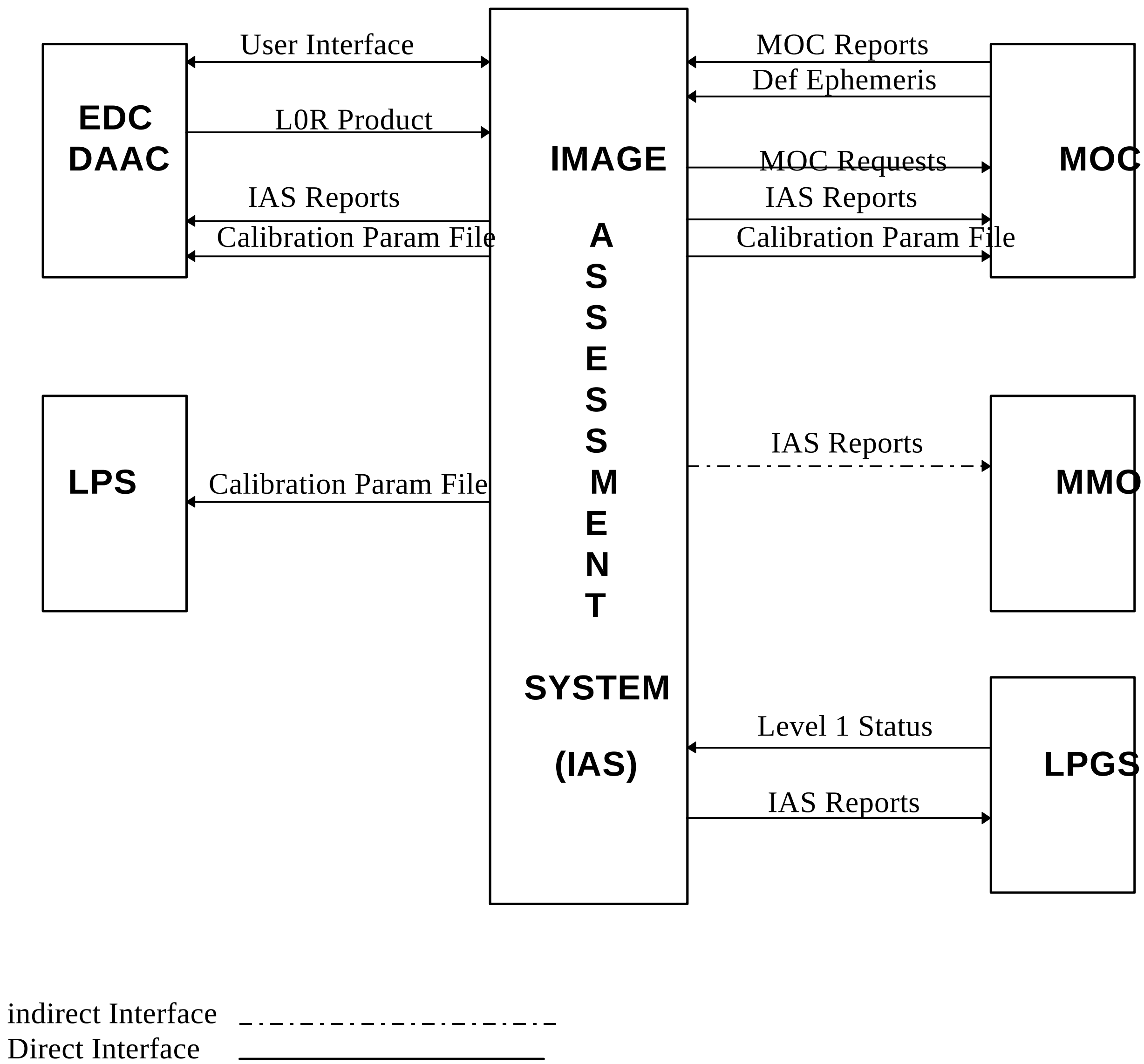

Figure 2-1. IAS Context Diagram

as Level 1 products. Image data are assessed with respect to their radiometric and geometric qualities on an individual sample and long term trending basis.

The IAS may also make requests of the MOC for concentrated ephemeris data and data acquisitions. The IAS receives the ephemeris data, both definitive and concentrated, from the MOC and uses the data for Geometric Calibration.

After proper analysis of the products from L0R processing, the IAS generates reports concerning Landsat 7 instrument appraisal. Additionally, the IAS produces a Calibration Parameter File (CPF) that provides the values used to process the L0R and are necessary to calibrate the Landsat 7 instruments. IAS sends both of these products to the EDC DAAC and MOC. The LPS also receives a copy of the CPF.

IAS sends data quality assessments, reports, and improved processing instructions to EDC DAAC, LPGS, LPS, MOC, and MMO.

2.1.3 General Definitions of Terms

The following are definitions of terms used throughout this document:

- Application Program (AP) -- A program that implements a function. Each application program has a set of input parameters associated with it
- L0R -- Unrefined image data from EDC DAAC
- Level 1R product (L1R) -- Radiometrically refined product from L0R data
- Level 1G product (L1G) -- Geometrically refined product from L0R or L1R data
- Work Order (WO) -- An order that specifies a procedure for IAS to process a L0R
- WO Script (WOS) -- A file of shell command language instructions that execute a set of APs.
- WO Procedure (WOP) -- A set of WO scripts.

2.2 External Interfaces

IAS has five external interfaces:

- EDC DAAC
- LPS
- MOC
- LPGS
- MMO

2.2.1 EDC DAAC

ECS support for the Landsat 7 science data is collocated with the Landsat 7 Ground System at EDC. ECS at the EDC DAAC provides: ingest of and long term storage for Landsat 7 image data sets and calibration coefficient files; EOSDIX user access to Landsat 7 browse images and a catalog of archived Landsat 7 data for data search and product order;, and distribution of products in response to orders.

The interface control document (ICD) that identifies the interface between IAS and the EDC DAAC is the controlling document for the interface between EDC DAAC and IAS. Henceforth, EDC DAAC will be referenced as DAAC in this document. The interfaces between the DAAC and IAS are

- IAS examines DAAC for L0R availability
- IAS requests L0Rs from DAAC
- DAAC provides L0Rs to IAS
- IAS provides CPF to DAAC
- IAS provides IAS reports to DAAC
  -- Calibration
  -- Assessment
  -- Evaluation
  -- Anomaly Resolution

2.2.2 LPS

The Landsat 7 Processing System (LPS) provides Landsat 7 data receive and processing support to the Landsat 7 program, in conjunction with the Earth Science Mission Operations (ESMO) Project. The LPS receives raw wideband data from the Landsat 7 Ground Station, located at the EDC, processes it into L0R, browse and metadata files, and provides them to the DAAC also located at EDC.

The *Interface Control Document (ICD) Between the Image Assessment System (IAS) and the Landsat-7 Processing System (LPS)* is the controlling document for the interface between LPS and IAS. The IAS provides LPS with the current CPF.

2.2.3 MOC

The MOC 's location is GSFC in Greenbelt, Maryland. MOC is the focal point for all Landsat 7 satellite operations. The MOC plans and schedules the operation of spacecraft and its science payload, the ETM+. To schedule contacts with the satellite, the MOC works with multiple, existing operational resources, including NASA institutional facilities and NOAA control centers. The MOC generates and validates real-time commands and stored command loads based on conflict-free schedules. During a contact, the MOC sends the commands and loads to a ground station for uplink to a spacecraft. The MOC monitors the health and status of the satellite through downlinked narrowband telemetry. The MOC analyzes the long-term performance of spacecraft subsystems

The *Landsat-7 Mission Operations Center (MOC) to Image Assessment System (IAS) Interface Control Document (ICD)* is the controlling document for the interfaces between MOC and IAS. The following identifies the interface data that passes between the MOC and the IAS.

- IAS requests concentrated ephemeris data and data acquisition from MOC
- MOC provides concentrated ephemeris data to IAS
- MOC provides MOC reports to IAS
  -- Telemetry Trending Analysis
  -- Spacecraft Status
  -- Event Schedules
  -- Ascenting/Descending Node
- IAS provides current CPF to MOC
- IAS provides IAS reports to MOC
  -- Problem (request for MOC report or MOC action)

2.2.4 LPGS

The LPGS is a source of ETM+ Level 1 data within the Earth Observatory Satellite (EOS) Ground System (EGS). The EGS is a collection of ground support elements for EOS. The collection includes the EOS Data and Information System (EOSDIS), institutional support elements, affiliated and international partner data centers, international partner instrument control and operations centers, and other source of data. The LPGS's location is also at the EDC. The LPGS provides ETM+ Level 1 product generation and distribution services on a demand basis.

The *Interface Control Document (ICD) Between the Image Assessment System (IAS) and the Level 1 Product Generation System (LPGS)* is the controlling document for the interface between LPGS and IAS. The only interface that passes between the LPGS and the IAS is the trending data from LPGS to IAS.

2.2.5 MMO

Short statement about "what the MMO is and does" is needed.
There is an indirect interface with MMO. The IAS provides MMO, via DAAC, with data created for other external interfaces. The available data for MMO are the quality assessments, reports, and improved processing instructions.

2.3 Hardware

The location of IAS hardware is with the LPS, LP and DAAC at the DAAC in Sioux Falls South Dakota. Figure 2-2 presents the IAS Hardware Architecture.

2.3.1 IAS Operations System Hardware

The IAS Operations System provides L0R computing and storage capabilities required for the IAS to Ingest L0Rs, to process to Level 1, and to perform calibration.

2.3.1.1 SGI Origin Server

The Silicon Graphics Incorporated (SGI) Origin Servers are multiprocessor systems designed for distributed computing environments. Their parallel architecture is based on a 1.2 Gigabytes (GB) per second system bus and can support up to 16 GB of RAM and 16 micro-processors. The IAS operations machine will initially have 2 GB of RAM. Among the items included with the standard system is an Ethernet controller, Versa Module Europena (VME)/64 controller, SCSI controller, parallel and serial ports.

IAS requires a multiprocessor solution to satisfy its computational requirements that are beyond the current capacity of a single processor.

The operation machine attaches to on-line and off-line storage through a SCSI controller. It connects to the operational hardware via an Ethernet Local Area Network (LAN) and to the

Development hardware and the Integration and Test (I&T) hardware via the Fiber Distributed Data Interface (FDDI) LAN.

2.3.1.2 X-Terminal

The operator Console hardware configuration consists of at least one (1) X-Terminal. The IAS operators use X-terminals to monitor and control processing on the Operations System. Each terminal connects to the operations machine via the operational Ethernet Local Area Network (LAN)

2.3.1.3 FDDI LAN

The image data FDDI LAN will connect the Operations, Landsat 7 I&T and Landsat 7 Development Systems with the network file appliance and the DAAC. The LAN rating is 100 megabytes per second (Mbps).

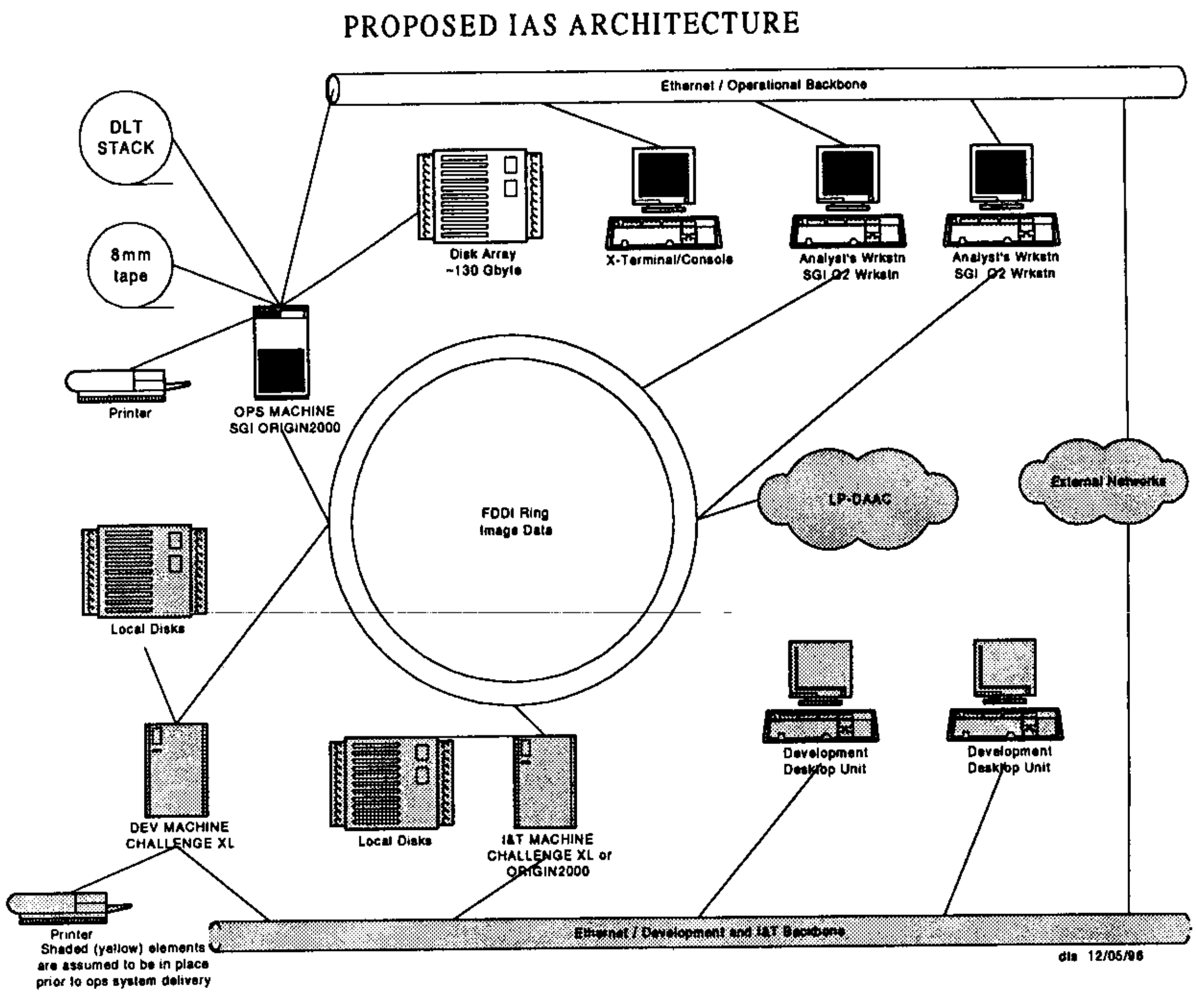

Figure 2-2. IAS Hardware Architecture.

2.3.1.4 SCSI Controllers

The Ultra-SCSI controller connects the primary on-line storage devices to the Operations System. The SCSI 2 controller provides additional ports for the external disk arrays and tape drive.

2.3.2 Image Analyst Workstation Hardware

The Image Analyst Workstation Hardware Configuration Item (HWCI) consists of SGI 02 workstations. The IAS Analysts use the workstations to perform data and image analysis, anomaly investigation and report generation activities.

These workstations connect to the IAS computers via the FDDI LAN. A secondary Ethernet LAN connection may be implemented if deemed necessary. Display resolution will be 1280 x 1024. These workstations will have two 4 GB disks and 512 Mbytes of RAM.

2.3.3 Landsat 7 Integration and Test System

The Landsat 7 IAS Integration & Test (I&T) System is either a SGI Challenge XL or SGI Origin2000 that all the Landsat 7 organizations at the DAAC share. It is primarily an I&T machine and secondarily a backup to the Operations System. Because of the secondary role as an operational backup, the I&T System will have a copy of the current IAS operational software installed on it. The I&T System attaches to the image data FDDI LAN and the development and I&T Ethernet.

2.3.4 Landsat 7 Development System

The Landsat 7 IAS Development System is a SGI Challenge XL that all the Landsat 7 organizations at the DAAC share. Personnel performing software development and maintenance use the development system. This system may have a copy of the current IAS operational software installed on it, but it is not an operational backup. The Development System does not have any extensive on-line storage directly attached. The system attaches to the image data FDDI LAN and the development and I&T Ethernet.

2.4 Software

IAS software (SW) architecture incorporates custom IAS applications and Commercial-off-the-shelf (COTS) and Non-development Item (NDI) system and support applications to meet its functional and performance requirements. The architecture is designed to minimize IAS software development time. As a result, the design incorporates several COTS products, including Oracle Database Management System (DBMS), Interactive Data Language (IDL), and Environment for Visualizing Imagery (ENVI). Reuse of existing radiometry and geometry prototypes is planned to the maximum extent possible. In addition, the architecture is designed for maximum reuse by LPGS.

2.4.1 IAS Application Software

The functional capabilities of IAS are divided into five (5) IAS application SW configuration items (SWCIs). Each SWCI corresponds to a subsystem. The subsystems for IAS are:

- Process Control Subsystem (PCS)
- Data Management Subsystem (DMS)
- Radiometric Processing Subsystem (RPS)
- Geometric Processing Subsystem (GPS)
- Evaluation and Analysis Subsystem (E&A)

The IAS Level 0 Data Flow Diagram (DFD), Figure 2-3, shows the subsystems and their logical interfaces. Section 2.5 provides an overview of the functional capabilities for each subsystem.

2.4.2 IAS Support Software

The IAS support SW consists of COTS system and application SW components that either satisfy IAS requirements directly or are needed to perform specific functions of the IAS. The following lists specific support SW incorporated into the design:

System SWCIs incorporated into the IAS include:

- IRIX 6.2 operating system (SGI version of UNIX)
- FDDI Device Interface
- TCP/IP SW
- Device drivers for system peripherals

COTS support applications SWCIs incorporated into the IAS design include:

- Oracle DBMS. IAS uses Oracle as a vehicle for generating and storing requests for image processing and collecting and monitoring image processing execution information. Oracle’s Structured Query Language (SQL) and SQL*Forms manage and manipulate the information. In addition, IAS radiometry and geometry applications use database calls to store characterization, correction, and calibration results and statistics and associate them with specific scenes or detectors.

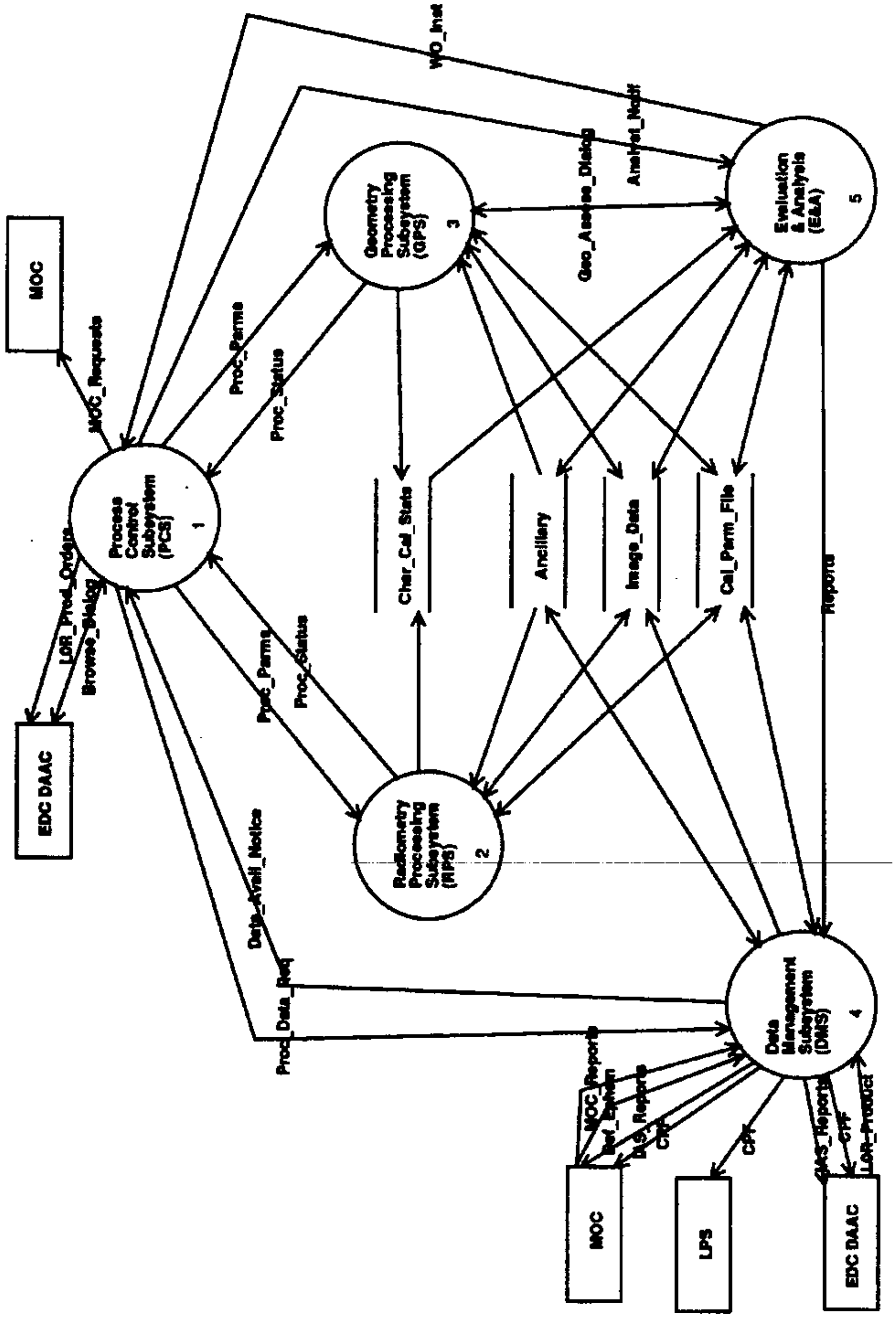

Figure 2-3. IAS Level 0 Data Flow Diagram (DFD).

- Oracle's SQL Forms and X/Motif Graphic User Interface (GUI) Tools. IAS uses the GUI tools as vehicles to present the IAS Operator with a simple and well-defined menu structure for controlling operations. The User Interface (UI) is based on X/Motif and Oracle's. SQL*Forms. X/Motif provides the basis for a consistent look and feel across multiple EDC systems because previously developed EDC systems use it.

- National Center for Supercomputer Applications (NCSA) Hierarchical Data Format (HDF). HDF tools manipulate the HDF-formatted L0R ingested from the DAAC and format IAS-generated products for transmission to the DAAC. The tools also manipulate HDF-formatted internal datasets.

- IDL. IAS development uses this tool to provide the IAS Analyst interface. IDL has a command line interpreter and other applications that satisfy the functional requirements for image analysis and manipulation. IDL has received wide acceptance in the science community at EDC and is being used by EDC in the development of IAS prototype applications.

- ENVI. This tool provides general purpose image processing applications that satisfy evaluation and analysis requirements. ENVI is built on IDL.

- Adobe FrameMaker. This tool provides a complete publishing software package, including word processing, page layout, graphics and tables, for producing IAS reports.

- Commercial Web Browser. This tool attaches the IAS to the DAAC and its search and ordering applications

- COTS SW development environment. The IAS development environment includes an American National Institute (ANSI) compliant C compiler, IRIX operating system, a debugger, Cadre/Teamwork CASE tool, and a *Power C Analyzer* (PCA) from SGI. The PCA provides the capability to analyze opportunities for parallel programming. Cadre/Teamwork CASE tool is used to prepare the graphic design of the software system. The charts and diagrams developed with this tool help to verify the design and are illustrations in this document. In addition, *Purify* and possibly other tools will be used to validate source code and to analyze memory leak problems. Polytrol Version Control System (PVCS) provides software configuration management for IAS.

NDI support application SWCIs incorporated into the IAS include the following EOSDIS Core System (ECS) applications:

- Earth Science Search Tool (ESST). This tool provides IAS with the capability to browse the DAAC holdings.

- Product Request Tool (PRT). This tool provides IAS with the ability to place orders for DAAC products.

- ECS Ingest GUI. This tool generates an ECS network ingest request form that transmission of IAS products to the ECS requires.
- EOS-HDF Toolkit. This toolkit formats ECS inputs into an internal EOS HDF format.

The NDI support applications execute on the DAAC servers.

2.5 Functional Capabilities

The IAS SWCIs correspond to the subsystems identified in Section 2.4.1 and depicted in Figure 2-3. The following subsections provide a functional overview for each subsystem. Section 3.3 identifies the purpose and functional activities for each subsystem.

2.5.1 Process Control Function

The Process Control function provides capabilities for planning, monitoring, and controlling the Level 1, Calibration, and Evaluation and Assessment processing performed on the IAS Operations system. It is used by the Operator when interacting with external systems to order input data products or to schedule data acquisitions. It permits the Operator to set up WOs specifying the processing to be performed on the data to prioritize the processing to be performed, and to monitor the status of the WO execution.

It also performs automated WO execution by monitoring required and available system resources, initiating application processing, and monitoring application execution status. It controls the execution of Radiometric and Geometric Processing by initiating and managing the L0R processing using the WO specified parameters.

2.5.2 Data Management Function

The Data Management function provides the tools required to ingest, archive, and distribute the IAS data. These data consists of image data, ancillary data, characterization and calibration results, and reports.

This function transfers data during ingest using File Transfer Protocol (ftp) functions, stores data in the appropriate internal data stores, and updates data availability information. For data export, Data Management performs the appropriate data formatting and supports the ftp transmission of these data to external systems.

Data Management performs quality checking and L0R correction upon receipt of the data from DAAC. Data Management also prepares data at the start of image processing by extracting the requested subset of data from Payload Correction Data (PCD), and possibly the Mirror Scan Correction Data (MSCD) and image files.

2.5.3 Radiometric Processing Function

The Radiometric Processing function performs radiometric calibration and Level-1 Radiometric (L1R) processing. The purpose of the radiometric calibration is to determine the calibration in-flight of each detector, that is the conversion from digital number to absolute radiance. The primary purpose of the L1R processing is to convert the brightness of the image pixels to absolute radiance. This is done prior to Level-1 Geometric (L1G) processing. This process uses various ground and in-flight determined calibrations. Another Radiometric Processing subfunction during L1R processing is to characterize the quality and various features of the data. A L0R is input to this function.

2.5.4 Geometric Processing Function

The Geometric Processing function performs geometric calibration and L1G processing. The Geometric Processing function processes raw (L0R) or radiometrically corrected (L1R) imagery into geometrically corrected (L1G) imagery. Another Geometric Processing subfunction during L1G processing is to characterize the quality and various features of the data. The L1G image can be processed to three levels; systematic (L1Gs), precision corrected (L1Gp) and precision/terrain corrected (L1Gt).

2.5.5 Evaluation and Analysis Function

Evaluation and Analysis function provides tools required by an IAS Analyst to evaluate and analyze the performance of the ETM+ instrument, perform anomaly investigations, and maintain the CPF. Included are capabilities for: viewing system inputs, processing reports, and results; data analysis; statistical analysis and trending; and report generation. It also provides the Analyst capabilities for editing system inputs and intermediate results and for submitting processing requests in support of “what if” analysis.

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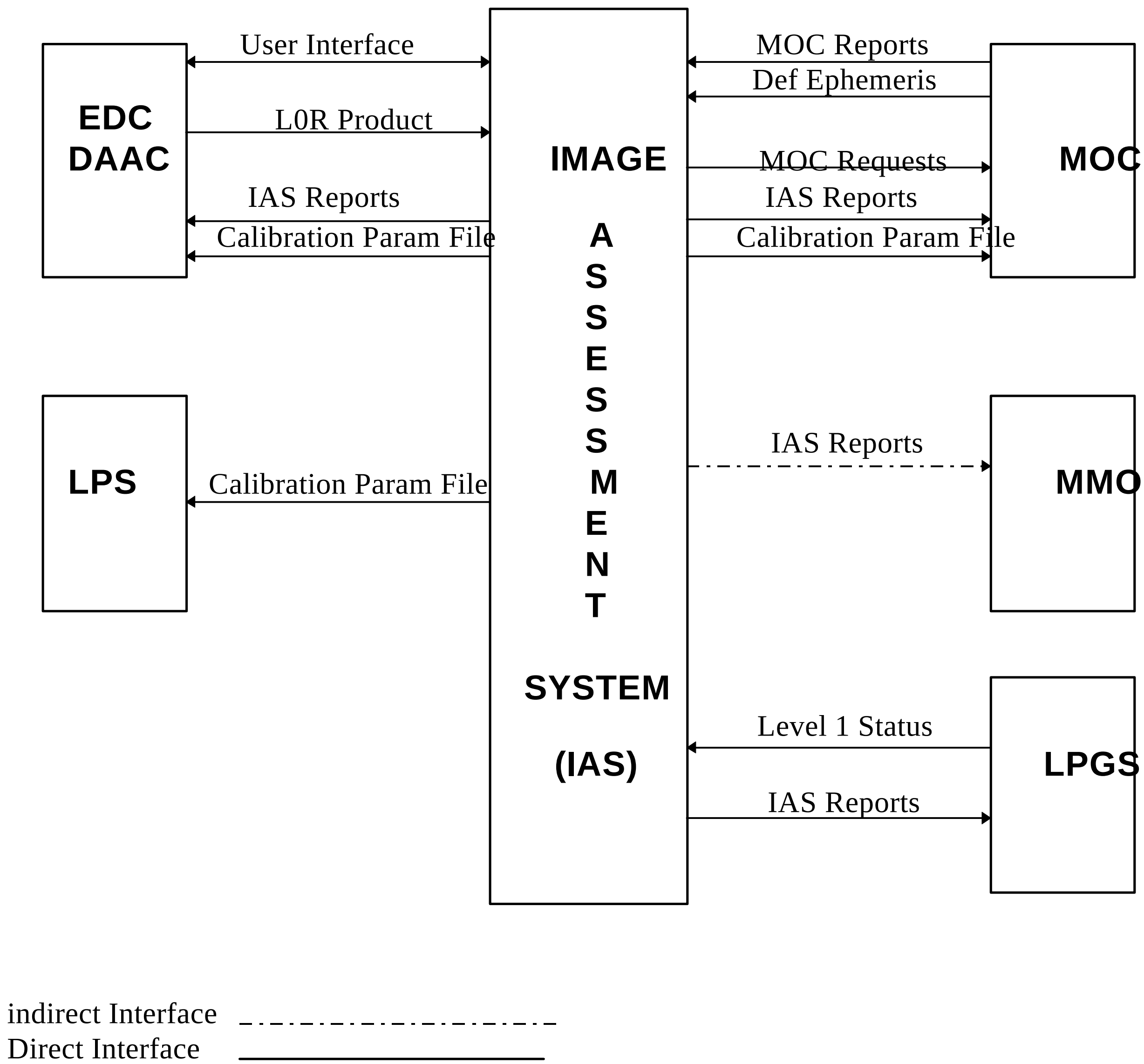

Figure 2-1. IAS Context Diagram

as Level 1 products. Image data are assessed with respect to their radiometric and geometric qualities on an individual sample and long term trending basis.

The IAS may also make requests of the MOC for concentrated ephemeris data and data acquisitions. The IAS receives the ephemeris data, both definitive and concentrated, from the MOC and uses the data for Geometric Calibration.

After proper analysis of the products from L0R processing, the IAS generates reports concerning Landsat 7 instrument appraisal. Additionally, the IAS produces a Calibration Parameter File (CPF) that provides the values used to process the L0R and are necessary to calibrate the Landsat 7 instruments. IAS sends both of these products to the EDC DAAC and MOC. The LPS also receives a copy of the CPF.

IAS sends data quality assessments, reports, and improved processing instructions to EDC DAAC, LPGS, LPS, MOC, and MMO.

2.1.3 General Definitions of Terms

The following are definitions of terms used throughout this document:

- Application Program (AP) -- A program that implements a function. Each application program has a set of input parameters associated with it
- L0R -- Unrefined image data from EDC DAAC
- Level 1R product (L1R) -- Radiometrically refined product from L0R data
- Level 1G product (L1G) -- Geometrically refined product from L0R or L1R data
- Work Order (WO) -- An order that specifies a procedure for IAS to process a L0R
- WO Script (WOS) -- A file of shell command language instructions that execute a set of APs.
- WO Procedure (WOP) -- A set of WO scripts.

2.2 External Interfaces

IAS has five external interfaces:

- EDC DAAC
- LPS
- MOC
- LPGS
- MMO

2.2.1 EDC DAAC

ECS support for the Landsat 7 science data is collocated with the Landsat 7 Ground System at EDC. ECS at the EDC DAAC provides: ingest of and long term storage for Landsat 7 image data sets and calibration coefficient files; EOSDIX user access to Landsat 7 browse images and a catalog of archived Landsat 7 data for data search and product order;, and distribution of products in response to orders.

The interface control document (ICD) that identifies the interface between IAS and the EDC DAAC is the controlling document for the interface between EDC DAAC and IAS. Henceforth, EDC DAAC will be referenced as DAAC in this document. The interfaces between the DAAC and IAS are

- IAS examines DAAC for L0R availability
- IAS requests L0Rs from DAAC
- DAAC provides L0Rs to IAS
- IAS provides CPF to DAAC
- IAS provides IAS reports to DAAC
  -- Calibration
  -- Assessment
  -- Evaluation
  -- Anomaly Resolution

2.2.2 LPS

The Landsat 7 Processing System (LPS) provides Landsat 7 data receive and processing support to the Landsat 7 program, in conjunction with the Earth Science Mission Operations (ESMO) Project. The LPS receives raw wideband data from the Landsat 7 Ground Station, located at the EDC, processes it into L0R, browse and metadata files, and provides them to the DAAC also located at EDC.

The *Interface Control Document (ICD) Between the Image Assessment System (IAS) and the Landsat-7 Processing System (LPS)* is the controlling document for the interface between LPS and IAS. The IAS provides LPS with the current CPF.

2.2.3 MOC

The MOC 's location is GSFC in Greenbelt, Maryland. MOC is the focal point for all Landsat 7 satellite operations. The MOC plans and schedules the operation of spacecraft and its science payload, the ETM+. To schedule contacts with the satellite, the MOC works with multiple, existing operational resources, including NASA institutional facilities and NOAA control centers. The MOC generates and validates real-time commands and stored command loads based on conflict-free schedules. During a contact, the MOC sends the commands and loads to a ground station for uplink to a spacecraft. The MOC monitors the health and status of the satellite through downlinked narrowband telemetry. The MOC analyzes the long-term performance of spacecraft subsystems

The *Landsat-7 Mission Operations Center (MOC) to Image Assessment System (IAS) Interface Control Document (ICD)* is the controlling document for the interfaces between MOC and IAS. The following identifies the interface data that passes between the MOC and the IAS.

- IAS requests concentrated ephemeris data and data acquisition from MOC
- MOC provides concentrated ephemeris data to IAS
- MOC provides MOC reports to IAS
  -- Telemetry Trending Analysis
  -- Spacecraft Status
  -- Event Schedules
  -- Ascenting/Descending Node
- IAS provides current CPF to MOC
- IAS provides IAS reports to MOC
  -- Problem (request for MOC report or MOC action)

2.2.4 LPGS

The LPGS is a source of ETM+ Level 1 data within the Earth Observatory Satellite (EOS) Ground System (EGS). The EGS is a collection of ground support elements for EOS. The collection includes the EOS Data and Information System (EOSDIS), institutional support elements, affiliated and international partner data centers, international partner instrument control and operations centers, and other source of data. The LPGS's location is also at the EDC. The LPGS provides ETM+ Level 1 product generation and distribution services on a demand basis.

The *Interface Control Document (ICD) Between the Image Assessment System (IAS) and the Level 1 Product Generation System (LPGS)* is the controlling document for the interface between LPGS and IAS. The only interface that passes between the LPGS and the IAS is the trending data from LPGS to IAS.

2.2.5 MMO

Short statement about "what the MMO is and does" is needed.
There is an indirect interface with MMO. The IAS provides MMO, via DAAC, with data created for other external interfaces. The available data for MMO are the quality assessments, reports, and improved processing instructions.

2.3 Hardware

The location of IAS hardware is with the LPS, LP and DAAC at the DAAC in Sioux Falls South Dakota. Figure 2-2 presents the IAS Hardware Architecture.

2.3.1 IAS Operations System Hardware

The IAS Operations System provides L0R computing and storage capabilities required for the IAS to Ingest L0Rs, to process to Level 1, and to perform calibration.

2.3.1.1 SGI Origin Server

The Silicon Graphics Incorporated (SGI) Origin Servers are multiprocessor systems designed for distributed computing environments. Their parallel architecture is based on a 1.2 Gigabytes (GB) per second system bus and can support up to 16 GB of RAM and 16 micro-processors. The IAS operations machine will initially have 2 GB of RAM. Among the items included with the standard system is an Ethernet controller, Versa Module Europena (VME)/64 controller, SCSI controller, parallel and serial ports.

IAS requires a multiprocessor solution to satisfy its computational requirements that are beyond the current capacity of a single processor.

The operation machine attaches to on-line and off-line storage through a SCSI controller. It connects to the operational hardware via an Ethernet Local Area Network (LAN) and to the

Development hardware and the Integration and Test (I&T) hardware via the Fiber Distributed Data Interface (FDDI) LAN.

2.3.1.2 X-Terminal

The operator Console hardware configuration consists of at least one (1) X-Terminal. The IAS operators use X-terminals to monitor and control processing on the Operations System. Each terminal connects to the operations machine via the operational Ethernet Local Area Network (LAN)

2.3.1.3 FDDI LAN

The image data FDDI LAN will connect the Operations, Landsat 7 I&T and Landsat 7 Development Systems with the network file appliance and the DAAC. The LAN rating is 100 megabytes per second (Mbps).

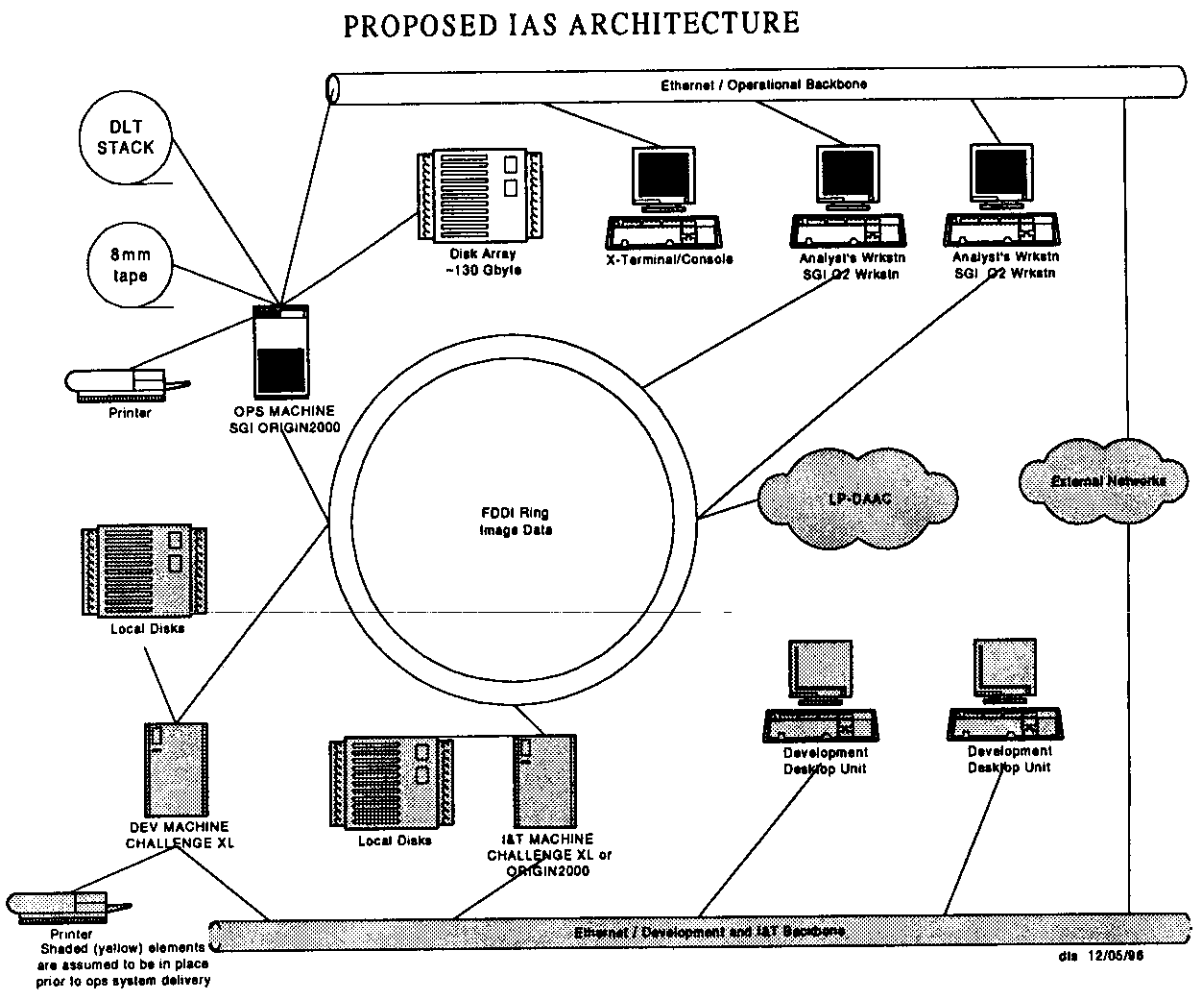

Figure 2-2. IAS Hardware Architecture.

2.3.1.4 SCSI Controllers

The Ultra-SCSI controller connects the primary on-line storage devices to the Operations System. The SCSI 2 controller provides additional ports for the external disk arrays and tape drive.

2.3.2 Image Analyst Workstation Hardware

The Image Analyst Workstation Hardware Configuration Item (HWCI) consists of SGI 02 workstations. The IAS Analysts use the workstations to perform data and image analysis, anomaly investigation and report generation activities.

These workstations connect to the IAS computers via the FDDI LAN. A secondary Ethernet LAN connection may be implemented if deemed necessary. Display resolution will be 1280 x 1024. These workstations will have two 4 GB disks and 512 Mbytes of RAM.

2.3.3 Landsat 7 Integration and Test System

The Landsat 7 IAS Integration & Test (I&T) System is either a SGI Challenge XL or SGI Origin2000 that all the Landsat 7 organizations at the DAAC share. It is primarily an I&T machine and secondarily a backup to the Operations System. Because of the secondary role as an operational backup, the I&T System will have a copy of the current IAS operational software installed on it. The I&T System attaches to the image data FDDI LAN and the development and I&T Ethernet.

2.3.4 Landsat 7 Development System

The Landsat 7 IAS Development System is a SGI Challenge XL that all the Landsat 7 organizations at the DAAC share. Personnel performing software development and maintenance use the development system. This system may have a copy of the current IAS operational software installed on it, but it is not an operational backup. The Development System does not have any extensive on-line storage directly attached. The system attaches to the image data FDDI LAN and the development and I&T Ethernet.

2.4 Software

IAS software (SW) architecture incorporates custom IAS applications and Commercial-off-the-shelf (COTS) and Non-development Item (NDI) system and support applications to meet its functional and performance requirements. The architecture is designed to minimize IAS software development time. As a result, the design incorporates several COTS products, including Oracle Database Management System (DBMS), Interactive Data Language (IDL), and Environment for Visualizing Imagery (ENVI). Reuse of existing radiometry and geometry prototypes is planned to the maximum extent possible. In addition, the architecture is designed for maximum reuse by LPGS.

2.4.1 IAS Application Software

The functional capabilities of IAS are divided into five (5) IAS application SW configuration items (SWCIs). Each SWCI corresponds to a subsystem. The subsystems for IAS are:

- Process Control Subsystem (PCS)
- Data Management Subsystem (DMS)
- Radiometric Processing Subsystem (RPS)
- Geometric Processing Subsystem (GPS)
- Evaluation and Analysis Subsystem (E&A)

The IAS Level 0 Data Flow Diagram (DFD), Figure 2-3, shows the subsystems and their logical interfaces. Section 2.5 provides an overview of the functional capabilities for each subsystem.

2.4.2 IAS Support Software

The IAS support SW consists of COTS system and application SW components that either satisfy IAS requirements directly or are needed to perform specific functions of the IAS. The following lists specific support SW incorporated into the design:

System SWCIs incorporated into the IAS include:

- IRIX 6.2 operating system (SGI version of UNIX)
- FDDI Device Interface
- TCP/IP SW
- Device drivers for system peripherals

COTS support applications SWCIs incorporated into the IAS design include:

- <u>Oracle DBMS</u>. IAS uses Oracle as a vehicle for generating and storing requests for image processing and collecting and monitoring image processing execution information. Oracle’s Structured Query Language (SQL) and SQL*Forms manage and manipulate the information. In addition, IAS radiometry and geometry applications use database calls to store characterization, correction, and calibration results and statistics and associate them with specific scenes or detectors.

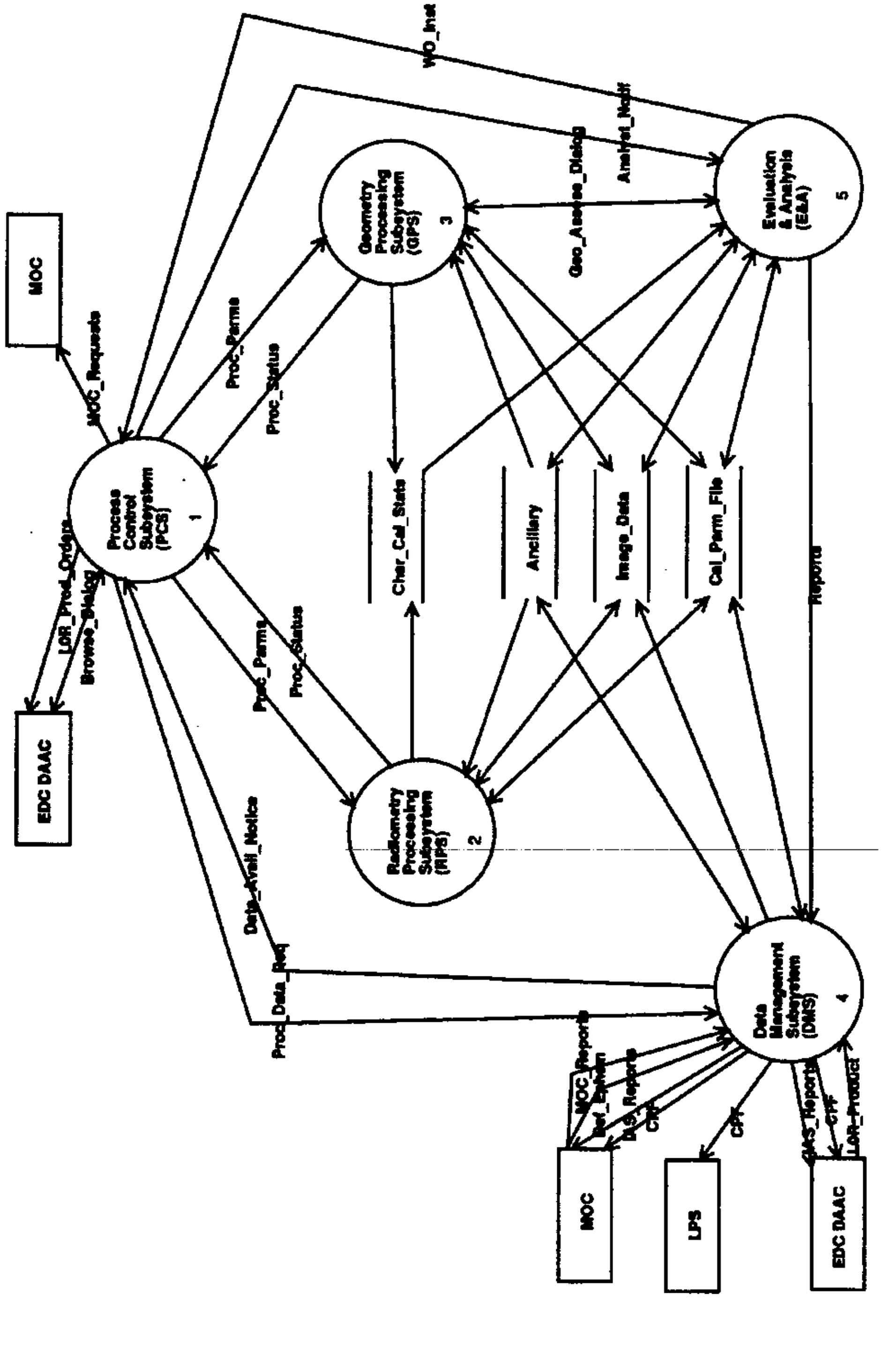

Figure 2-3. IAS Level 0 Data Flow Diagram (DFD).

- Oracle's SQL Forms and X/Motif Graphic User Interface (GUI) Tools. IAS uses the GUI tools as vehicles to present the IAS Operator with a simple and well-defined menu structure for controlling operations. The User Interface (UI) is based on X/Motif and Oracle's. SQL*Forms. X/Motif provides the basis for a consistent look and feel across multiple EDC systems because previously developed EDC systems use it.

- National Center for Supercomputer Applications (NCSA) Hierarchical Data Format (HDF). HDF tools manipulate the HDF-formatted L0R ingested from the DAAC and format IAS-generated products for transmission to the DAAC. The tools also manipulate HDF-formatted internal datasets.

- IDL. IAS development uses this tool to provide the IAS Analyst interface. IDL has a command line interpreter and other applications that satisfy the functional requirements for image analysis and manipulation. IDL has received wide acceptance in the science community at EDC and is being used by EDC in the development of IAS prototype applications.

- ENVI. This tool provides general purpose image processing applications that satisfy evaluation and analysis requirements. ENVI is built on IDL.

- Adobe FrameMaker. This tool provides a complete publishing software package, including word processing, page layout, graphics and tables, for producing IAS reports.

- Commercial Web Browser. This tool attaches the IAS to the DAAC and its search and ordering applications

- COTS SW development environment. The IAS development environment includes an American National Institute (ANSI) compliant C compiler, IRIX operating system, a debugger, Cadre/Teamwork CASE tool, and a *Power C Analyzer* (PCA) from SGI. The PCA provides the capability to analyze opportunities for parallel programming. Cadre/Teamwork CASE tool is used to prepare the graphic design of the software system. The charts and diagrams developed with this tool help to verify the design and are illustrations in this document. In addition, *Purify* and possibly other tools will be used to validate source code and to analyze memory leak problems. Polytrol Version Control System (PVCS) provides software configuration management for IAS.

NDI support application SWCIs incorporated into the IAS include the following EOSDIS Core System (ECS) applications:

- Earth Science Search Tool (ESST). This tool provides IAS with the capability to browse the DAAC holdings.

- Product Request Tool (PRT). This tool provides IAS with the ability to place orders for DAAC products.

- ECS Ingest GUI. This tool generates an ECS network ingest request form that transmission of IAS products to the ECS requires.
- EOS-HDF Toolkit. This toolkit formats ECS inputs into an internal EOS HDF format.

The NDI support applications execute on the DAAC servers.

2.5 Functional Capabilities

The IAS SWCIs correspond to the subsystems identified in Section 2.4.1 and depicted in Figure 2-3. The following subsections provide a functional overview for each subsystem. Section 3.3 identifies the purpose and functional activities for each subsystem.

2.5.1 Process Control Function

The Process Control function provides capabilities for planning, monitoring, and controlling the Level 1, Calibration, and Evaluation and Assessment processing performed on the IAS Operations system. It is used by the Operator when interacting with external systems to order input data products or to schedule data acquisitions. It permits the Operator to set up WOs specifying the processing to be performed on the data to prioritize the processing to be performed, and to monitor the status of the WO execution.

It also performs automated WO execution by monitoring required and available system resources, initiating application processing, and monitoring application execution status. It controls the execution of Radiometric and Geometric Processing by initiating and managing the L0R processing using the WO specified parameters.

2.5.2 Data Management Function

The Data Management function provides the tools required to ingest, archive, and distribute the IAS data. These data consists of image data, ancillary data, characterization and calibration results, and reports.

This function transfers data during ingest using File Transfer Protocol (ftp) functions, stores data in the appropriate internal data stores, and updates data availability information. For data export, Data Management performs the appropriate data formatting and supports the ftp transmission of these data to external systems.

Data Management performs quality checking and L0R correction upon receipt of the data from DAAC. Data Management also prepares data at the start of image processing by extracting the requested subset of data from Payload Correction Data (PCD), and possibly the Mirror Scan Correction Data (MSCD) and image files.

2.5.3 Radiometric Processing Function

The Radiometric Processing function performs radiometric calibration and Level-1 Radiometric (L1R) processing. The purpose of the radiometric calibration is to determine the calibration in-flight of each detector, that is the conversion from digital number to absolute radiance. The primary purpose of the L1R processing is to convert the brightness of the image pixels to absolute radiance. This is done prior to Level-1 Geometric (L1G) processing. This process uses various ground and in-flight determined calibrations. Another Radiometric Processing subfunction during L1R processing is to characterize the quality and various features of the data. A L0R is input to this function.

2.5.4 Geometric Processing Function

The Geometric Processing function performs geometric calibration and L1G processing. The Geometric Processing function processes raw (L0R) or radiometrically corrected (L1R) imagery into geometrically corrected (L1G) imagery. Another Geometric Processing subfunction during L1G processing is to characterize the quality and various features of the data. The L1G image can be processed to three levels; systematic (L1Gs), precision corrected (L1Gp) and precision/terrain corrected (L1Gt).

2.5.5 Evaluation and Analysis Function

Evaluation and Analysis function provides tools required by an IAS Analyst to evaluate and analyze the performance of the ETM+ instrument, perform anomaly investigations, and maintain the CPF. Included are capabilities for: viewing system inputs, processing reports, and results; data analysis; statistical analysis and trending; and report generation. It also provides the Analyst capabilities for editing system inputs and intermediate results and for submitting processing requests in support of “what if” analysis.

Section 3. Design Overview

This section provides an overview of the IAS critical design. It discusses the design methodology, design considerations, and software design. This section also describes the open issues that have a potential impact on the IAS detailed design and implementation.

3.1 Design Methodology

This section provides a brief description of the methods used to perform the critical design of the IAS, including the design process and products.

3.1.1 Design Process

The IAS critical design was developed using the appropriate Systems, Engineering, and Analysis Support (SEAS) System Development Methodology (SSDM) and associated SSDM standards that were tailored to meet the requirements of the IAS project environment. The following are the major activities performed to design the IAS:

- Development of an IAS top level architecture that is based on IAS structured design and conforms to the selected hardware configuration and constraints.
- Design of the IAS database by refining a logical model of the IAS data.
- Design of a user interface for the IAS, based on software requirements and operations concepts.
- Design of the IAS subsystems using a CASE tool, Cadre/Teamwork, which supports the structured design methodology.
- Identification of IAS issues that, when resolved, may impact the IAS critical design.

3.1.2 Design Products

Several products resulted from the critical design phase of the IAS. They include:

- A model of the IAS design in the Cadre/Teamwork CASE tool that describes the software design. This model includes:
    - Structure charts that are graphical representations of the hierarchy of the IAS modules. Structure charts consist of modules, data and control couples that are passed between modules.

- Module specifications (M-Specs) that describe what function each module is to perform and how it performs it.
- A data dictionary that provides definitions for data items in the IAS software design.

- Entity relationship diagrams that define the attributes of each entity and depict the relationship among entities. These diagrams also include constraints that enforce the integrity of the database.

- This Critical Design Specification.

3.1.3 Design Conventions

The IAS design uses a notation adapted from E. Yourdon and L. Constantine and supported by the CADRE/Teamwork CASE tool. Figure 3-1 illustrates the notation. The notation is consistent with SSDM standard 4205 but includes these enhancements and exceptions.

- Unit representation on structure charts include only a title; they do not include a purpose statement. The conditional execution symbol is used for transaction centers as well.

- Signals (UNIX software interrupts) are represented by asynchronous invocation from an off-sheet connector without source.

- Figure 3-1(g) illustrates the special notations used for IAS Global functions, data units, and database access routines.

3.2 Design Considerations

This subsection presents the concepts and philosophy that drive the IAS design.

3.2.1 IAS Top Level Architecture Control Strategies

This section defines the rationale behind the IAS control strategy design. There are three significant areas of the design. They are multiple image assessment capability, WO processing and database support.

The preliminary design applied a strategy that allows for the processing of multiple L0Rs at the same time. Consequently, the IAS development allows parallel geometric and radiometric processing of multiple L0Rs.

To facilitate multiple image assessment processing, a WO system was developed. It was determined that a system guided by WOs provides the easiest mechanism for maintaining control over the multiple processes. WOs specify all of the necessary information needed for image assessment. This information includes the identification of the L0R for processing, input

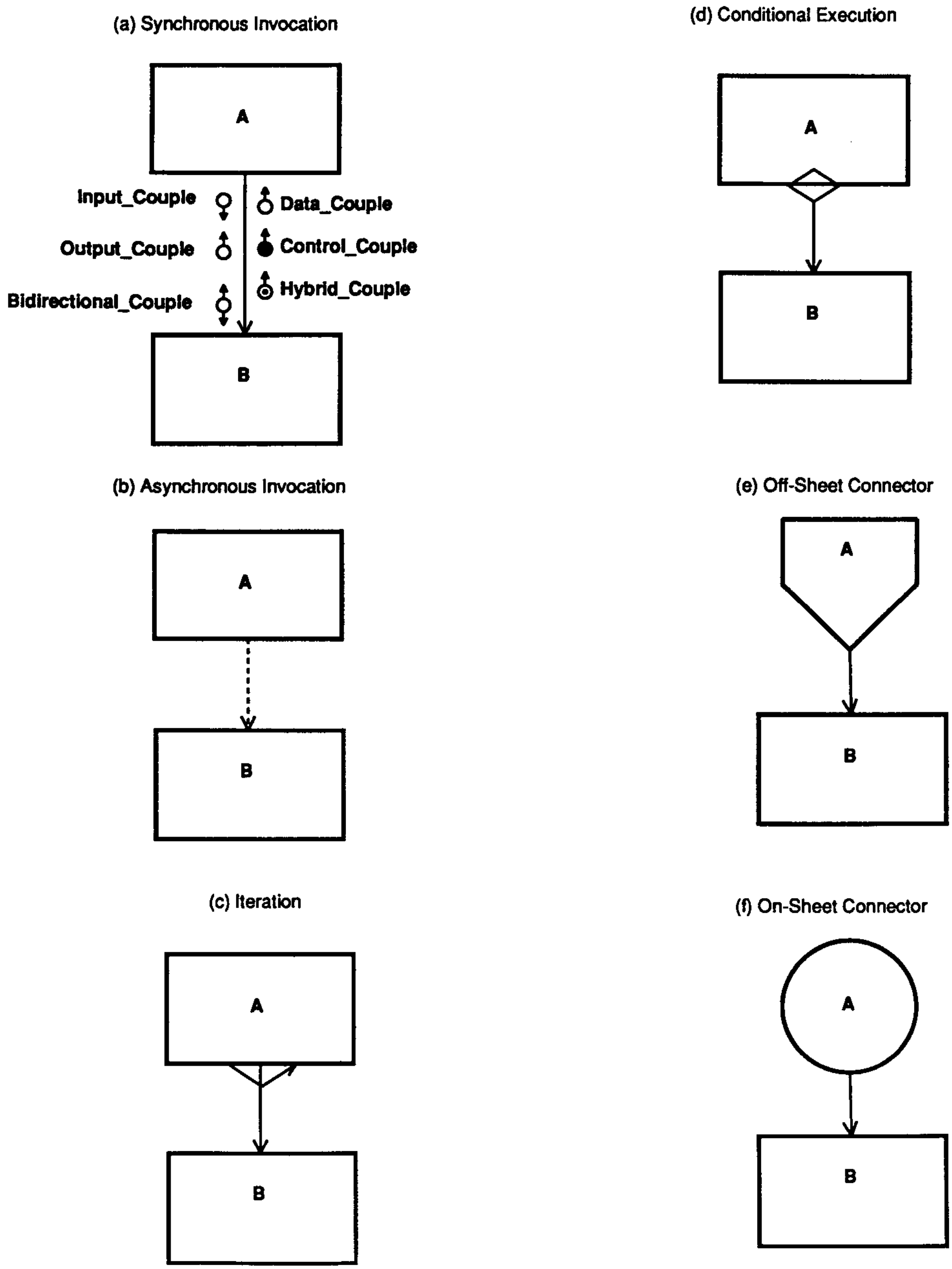

Figure 3-1. Conventions for Detailed Design (1 of 2).

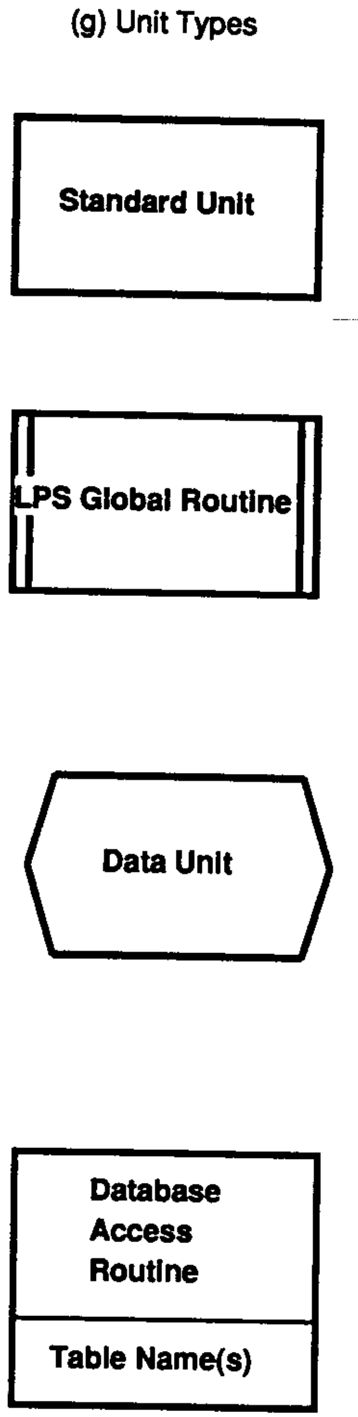

Figure 3-1. Conventions for Detailed Design (2 of 2).(to be modified)

parameters, and WO priority. The current status of image assessment for a given product can always be determined using the WO identification.

It was also decided that a relational DBMS would be used to support image assessment. The database will be used to store both work information and its parameters. This will make it easier to perform “what if?” analysis. The database will also act as a repository for trending data that will aid in trending analysis

3.2.2 Global Routines

There is a single library (global library) that contains global routines to provide general purpose processing throughout IAS. In addition, IAS uses global routines to ensure that the radiometric and geometric processes operate the same in IAS and LPGS.

Any function required by more than one subsystem or provides processing that must be the same as that performed by LPGS will be implemented as a global routine.

3.2.3 Database Interface

A trade-off study resulted in the decision to place all database access through embedded SQL in separate Database Access Routines (DBARS) that contain little more than the SQL statements themselves. The rationale for doing so is that these smaller units run less risk of encountering compile-time problems with the Oracle embedded SQL preprocessor.

3.2.4 User Interface

The IAS mode of processing is generally divided into two scenarios: running known procedures and user analysis.

When the IAS processing is standardized such that a known set of procedures will be executed for a given situation, these procedures should be set up ahead of time and the user interaction required should be kept to a minimum. For example, for a daily assessment of ETM+ data, the user should be able to launch a procedure, while specifying only the ID of the scene to be processed. In order to facilitate this, the IAS user interface should support an environment of setting up “scripts” of defined processes into procedures, setting default parameters, launching procedures with the minimum of user involvement, and the ability to send procedures into batch mode.

While the standard IAS processing mode may be preset, the analysis functions of the IAS are much more free-form. In this mode, the analyst must be able to run individual processes as well as procedures and have the ability to change parameters from their default values.

The set of application that will require a user interface are as follows:

- All image processing applications (e.g., apply radiometric calibration, ingest, process Full Aperture Solar Calibrator (FASC), geometric sensor alignment calibration)
- Current system status
- Job scheduling
- Trending
- Reporting
- Scene ordering and tracking

The operator interface uses Web Browser software, ORACLE forms, and X-based GUI displays to provide the operator with a menu driven user interface. The analyst interface uses ENVI and IDL running under X windows to provide the analyst with a menu-driven window environment for evaluation and assessment functions. The screens in both interfaces will employ the same look and feel to minimize specific operations.

3.2.5 Processing Overview

The following subsections identify the operations profiles and the processing flow for IAS.

3.2.5.1 Operations Profiles

From a processing view, there are three types of functional users: operator, radiometric analyst, and geometric analyst. One person could perform more than one function. The expectation is that there will be at least one operator and one analyst. To perform any of the functions, the user must have the appropriate access rights.

- The operator starts the system, supports the analysts, and monitors WO tasks.

- An analyst views information about instruments onboard a spacecraft and uses the IAS geometric or radiometric calibration capabilities to perform "what if" situations for the instruments.

IAS operates 24 hours per day, seven (7) days a week. An operator and two (2) analysts attend the IAS eight (8) hours per day, five (5) days a week.

Section 4 provides detailed scenarios of user interaction with the IAS.

3.2.5.2 Processing Flow

The following presents the general flow of activities performed by personnel and IAS, as an image processes into a Level 1 product.

- The IAS operator browses the DAAC and finds a new holding that needs assessment. The operator generates a request for the appropriate L0R with the DAAC. The operator then generates a WO on the IAS for the requested L0R. The WO specifies the L0R identity, processing procedure and its parameters, and the priority for processing the WO. This WO is the stimulus that causes IAS to begin scheduling L0R processing.

- The operator may also generate and send requests to the MOC for acquisition data and concentrated ephemeris data appropriate for planned processing requests.

- The MOC sends the requested ephemeris data and reports to a designated IAS directory. The IAS detects the arrival of data from the MOC. Once it has arrived, IAS converts the ephemeris data to the local format and catalogs it. The MOC reports are stored for later review by operator or analyst.

- When IAS detects the arrival of a data availability notice (DAN) from the DAAC for a requested L0R, IAS retrieves the L0R product from DAAC. The IAS verifies the consistency and quality of the retrieved files, and catalogs it. Then IAS associates the verified L0R with a processing request (WO).

- After updating the WO with appropriate L0R, IAS schedules the L0R for processing based on the WO priority and available system resources. IAS performs radiometric and geometric processing using WO specified parameters.

- The IAS produces L1R generation, radiometric calibration, radiometric characterization, and evaluations from the L0R. The system also produces L1G, geometric calibration, geometric characterization and evaluation from either an L0R or an L1R.

- After the completion of radiometric and geometric processing, the WO pauses and IAS prompts the Analyst for further action. The IAS Analyst can select the option to perform further analysis using the IAS or mark the processed data completed.

- The IAS supports the Analyst in evaluating and analyzing the performance of the ETM+ instrument and assists the analyst in anomaly resolution. The IAS provides utilities to view radiometric and geometric processing inputs, intermediate products and results. It allows the analyst to perform “what if?” analysis. The system is also responsible for creating and updating trending data and generating analysis reports. The IAS saves the generated reports in a data base and if necessary, updates the CPF.

- The IAS provides system cleanup of files and distributes the IAS reports to the MOC, DAAC, and LPGS. The system also distributes the updated CPF to the MOC, LPS and DAAC.

3.2.5.3 WO Processing

As defined in Section 2.1.3, a WO specifies a WOP that is a set of WOSs. Each WOS is a file containing shell command language instructions that execute a set of APs. Figure 3-2 provides a pictorial description of a WOP. A WO is the stimulus that causes IAS to begin scheduling L0R processing. IAS uses the data within a WO to identify the L0R for processing, to provide parameters for processing and scheduling, and to monitor the image processing as it occurs.

IAS allows the user to create or modify WOs. The following identifies the processing associated with a WO:

- If the user requests the capability to create a new WO, IAS displays a form for user entry of data. The form presents the default values for a specified WOP that may be overridden by the user. Finally, the form creates a WO that identifies the L0R, processing procedure, and processing parameters.

- If the user requests the capability to modify, the IAS displays a previously created WO. IAS allows the user to change the attributes before scheduling the execution of the WO.

- When the data are available and image processing is ready to occur, IAS uses the WOP to identify what the user wants to occur to the data. The IAS performs image processing according to the sequence of the APs identified in each WOS of the WOP. Within a WOS, the user can set a pause to allow an analyst to review results at intermediate steps.

- When a pause occurs, the IAS prompts the analyst for further action. The IAS Analyst performs further analysis using the IAS and informs IAS to resume processing.

- When the last WO in a WOP finishes, IAS marks the WO as completed and prompts the IAS Analyst to perform an assessment of the WO. Using IAS, the analyst performs radiometric and geometric evaluation on the WO. After completing the assessment, the IAS Analyst marks the WO as analyzed.

- When a WO is marked as analyzed, the IAS performs system cleanup and distributes the completed data in manner specified within WO.

REVIEW

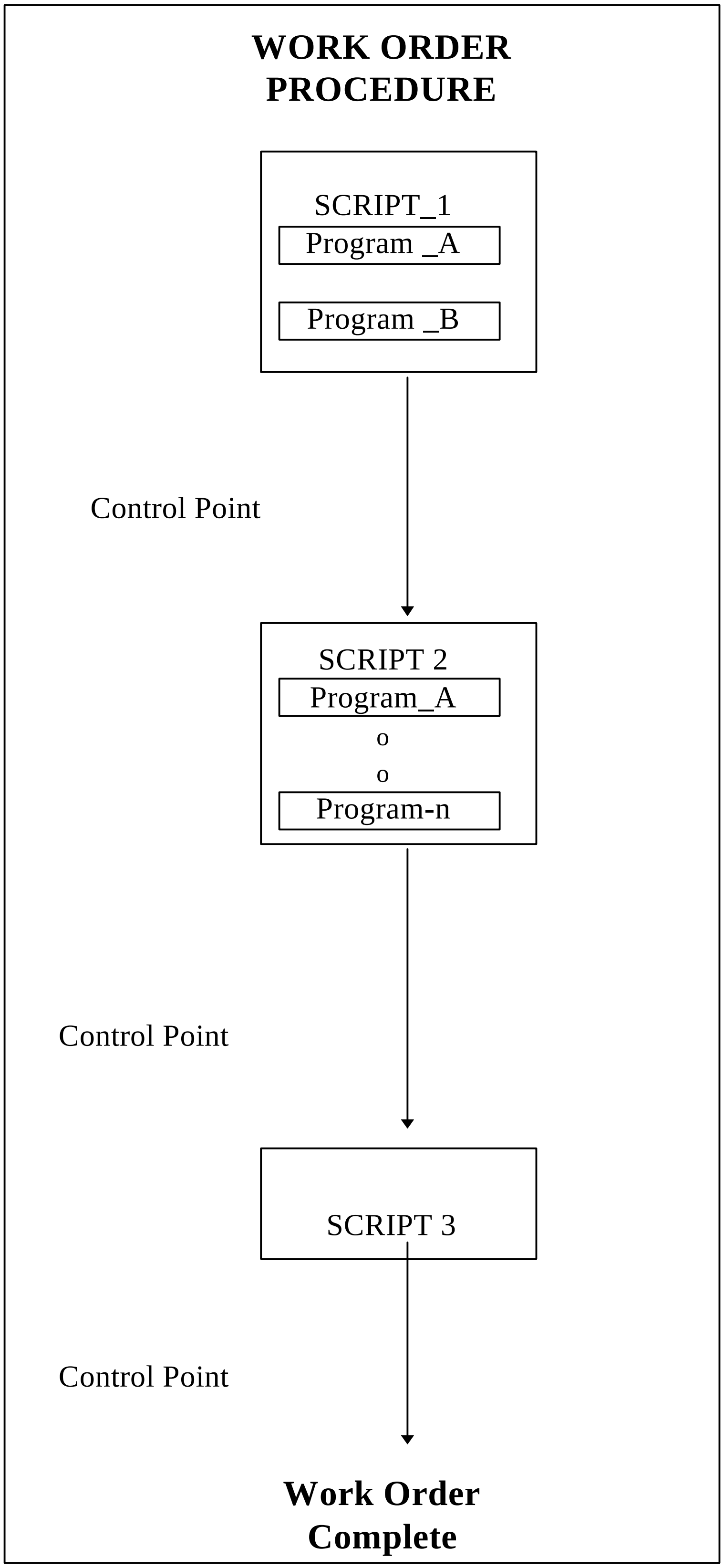
WORK ORDER
PROCEDURE
SCRIPT_1
Program _A
Program _B
Control Point
SCRIPT 2
Program_A
o
o
Program-n
Control Point
SCRIPT 3
Control Point
Work Order
Complete

Figure 3-2. Work Order Procedure (WOP).

3.2.5.4 AP Ground Rules

The IAS Builds an environment in which a WO executes. Thus, the radiometric and geometric APs must be designed to operate in this environment as well as in a standalone environment. IAS will provide global routines ito enable the APs to ingest input parameters from IAS and to output trending data to IAS. These same routines will support standalone execution. IAS will also provide global routines for the APs to access the L0R, CPF, and FDF ephemeris data.

The default WO directory is where the radiometric and geometric APs are executed. This default directory contains a /save subdirectory for storing all the data that will be archived to a tape after the WO assessment is completed. In addition, there is a /temp subdirectory for storing data that will not be archived. It is expected that the APs will establish a naming convention for intermediate files that will be used by APs in the same or different WOs.

The APs may write to the event log or the WO log. The operator will access the event log to determine the status of a WO. The operator or maintenance personnel will access the WO log to investigate software problems. Thus the event log contains a brief message from an AP; whereas, the WO log contains a detailed message from an AP.

3.2.6 File Maintenance

The IAS design provides for the processing, generation or maintenance of the following files:

- WO log file
- L0R input files.
- Flight Dynamics Facility (FDF) definitive or concentrated ephemeris
- Intermediate files from radiometric APs
- Intermediate files from geometric APs
- L1R output files generated by radiometric APs
- L1G output files generated by geometric APs
- Updated CPF
- Temporary (scratch) files
- IAS generated output reports
- IAS input reports from MOC (Telemetry Trending Analysis Reports, Spacecraft Status Reports, and Event Schedule Reports)
- Archive files

The deletion of temporary files created by various IAS software components occur at the end of the WO assessment by analyst. The following paragraphs identify IAS file deletion and archival processing for WOs and their results:

- L0Rs received from the DAAC and ephemeris files received from the MOC are tracked through the database. L0Rs are available for on-line use only as long as the WO processing needs them. When there are no WOs using an L0R as input, the deletion of the product from on-line storage occurs. In special cases, IAS archives an L0R but usually IAS obtains the products from the DAAC as needed. IAS keeps definitive ephemeris data on-line for the life of the mission. IAS handles concentrated ephemeris files the same manner as L0Rs and removes them from on-line storage when they no longer needed for WO processing. The deletion of L0Rs and concentrated ephemeris files is handled automatically by the IAS data management functional process.

- IAS places files created as a result of WO processing in a directory associated with the specific WO. This directory has two subdirectories; one holds files for archiving and a second holds scratch files. These files are not individually tracked, rather the location of the directory holding the files is retained in the IAS database. Files created while processing a WO will remain on-line until the WO is marked as analyzed. When a WO is marked analyzed (i.e., all reviews of output products have been completed), files in the archive subdirectory are tarred to a staging directory and the WO directory and its subdirectories are deleted. At a later time, the operator copies the TAR file to a tape. The location of the archive tar file for a WO is maintained in the database. The archiving and deletion of result output files (WO, L1R and L1G, and any other reports associated with a completed WO) occur automatically.

- It is assumed that the analysts will complete their review of WO processing results within 3 days of the completion of the WO (excluding Intergovernmental Oceanographic Commission (IOC) and anomaly resolution). When an extended period of time is required to analyze results, it may be necessary to remove the results files from on-line to off-line storage or to a local workstation storage. The analyst creates a copy of the results files and marks the WO as analyzed but with suspect quality (the quality indicator can be changed once the analysis is complete). This allows the IAS data management process to archive and delete the results files from the production area while still allowing the analyst time to complete the analysis.

Telemetry Trending Analysis Reports, Spacecraft Status Reports, and Event Schedule Reports are obtained from the MOC. These files are not tracked in the database and are managed manually in the IAS.

3.2.7 Error Handling Philosophy

The IAS error handling philosophy provides for error detection by a monitor and reporting process. Generally, each process that performs a function is invoked and monitored by a controlling process. The IAS error handling philosophy distinguishes a number of classes of errors. A primary distinction is made between correctable and uncorrectable errors.

3.2.7.1 Error Reporting

IAS error reporting consists of detailed error and status messages delivered throughout processing. Messages are reported to either the database event log, system log, and/or work order log depending on the IAS task. The IAS reports each detected error by the unit that first encounters the error.

Error and status messages requiring the user's (operator or analyst) attention are written to the IAS database event log. The user can query these events based on work order id, work order script, program name, time, message severity, or L0R product id.

Error and status messages requiring the IAS software developer's attention are written to the IAS system log. To aid in troubleshooting, the time, filename, process id, and the source code line number is appended to each message.

Error and status messages encountered by radiometric and geometric processing software will be written to the work order log. To aid in troubleshooting, the time, filename, process id, and the source code line number is appended to each message.

3.2.7.2 Error Processing

The IAS design treats most errors as uncorrectable and terminates execution gracefully when an error occurs. This decision is intended to minimize development costs without impact to system requirements. The decision is feasible because operations on the IAS are repeatable. An uncorrectable error that terminates execution is therefore corrected by repeating the operation that terminated.

3.2.7.2.1 Correctable Errors

In IAS, a correctable error is reported and handled in the unit that detects it.

3.2.7.2.2 Uncorrectable Errors

An uncorrectable error in the functioning process is detected by the monitoring process. In most cases, correction after a fatal error is unnecessary; the IAS's state remains unchanged until the process terminates successfully.

Uncorrectable errors fall into two categories, fatal and non-fatal.

- Fatal Errors. These errors cause a process to terminate abnormally and immediately. No opportunity for recovery exists at the time the error occurs. Catastrophic hardware failures or receipt of an operating system signal, such as UNIX SIGKILL, are events that can cause a process to terminate abnormally.
- Non-fatal Errors. These errors make further processing impossible but do not abort the process. The process is able to respond to the error at the time of its occurrence.

3.2.8 Open Issues

The following items pertaining to IAS Critical Design are still TBD:

- Mechanism for DAAC's notification to IAS on availability of L0R product.
- Mechanism for LPGS to transfer trending data to IAS
- Detailed layout of reports from IAS to MMO
- Transfer of products to DAAC is a manual process (DAAC GUI used to identify file and location)

3.3 Software Design

IAS contains five (5) SWCIs that correspond to the subsystems indentified in Section 2.4.1 and depicted in Figure 2-3, IAS Level 0 Data Flow Diagram (DFD). In addition to the subsystems, IAS includes global routines that provide the general processing across the system and IAS ans LPGS common processing. DMS provides the interface with the external entities.

The following subsections identify the purpose and functional activities for the global routines and the subsystems. Sections 6 through 10 provide detailed descriptions of the subsystems' designed software.

3.3.1 Global Routines -- Utilities (xxx)

The global routines provide functional capabilities for use by more than one subsystem or task. These routines are called by a task with appropriate parameters to perform the general processing required by the task. The global routines facilitate the radiometric and geometric processing within the IAS core system. With these routines the processing may execute in LPGS unchanged or execute in standalone mode on a workstation. The identified global routines are:

- WO specific (e.g., retrieve parameters, write trending data)
- Database
- L0R Input/output
- Interprocess communication
- System (miscellaneous)
- Image product building

3.3.2 Process Control Subsystem (PCS)

The PCS provides the functional capabilities to control the processing within IAS. The following identifies the processing performed by PCS:

- Receives a WO from an operator
- Receives a WO L0R information from DMS
- Schedules a fully specified WO with DAN information for processing according to priority and resources
- Sends necessary processing parameters to RPS and GPS when a WO is running
- Prompts analyst to refine intermediate results for paused WO
- Prompts Analyst to determine if further actions are needed after RPS and GPS processing is completed
- Receives reply from Analyst
- Provides access to E&A if Analyst wants to perform further actions

3.3.3 Data Management Subsystem (DMS)

The DMS manages the storing and retrieval of data and the interactions among the external interfaces and the IAS. The following identifies the processing performed by DMS:

- Detects delivery of ephemeris and acquisition data from the MOC
- Converts received ephemeris data to local format and catalogs it
- Stores received MOC reports
- Receives DAN for a requested L0R from DAAC
- Retrieves the L0R from the DAAC
- Verifies the quality and consistency of L0Rs
- Retrieves the appropriate WO and updates it with correct file names
- Sends WO containing L0R information to PCS
- Receives analysis reports from E&A
- Updates CPF if requested by E&A
- Performs file cleanup
- Distributes reports to MOC and DAAC
- Distributes updated CPF to MOC, LPS, and DAAC

3.3.4 Radiometric Processing Subsystem (RPS)

The RPS provides all the processing necessary to generate a L1R from a L0R. The following identifies the processing performed by RPS at the scheduled time of a WO:

- Receives WO processing parameters from PCS

- Performs radiometric calibration
- Performs radiometric characterization
- Evaluates L0R
- Produces L1R

3.3.5 Geometric Processing Subsystem (GPS)

The GPS provides all the processing necessary to generate a L1G from either a L0R or a L1R. The following identifies the processing performed by GPS at the scheduled time of a WO:

- Receives WO processing parameters from PCS
- Performs geometric calibration
- Performs geometric characterization
- Evaluates L0R or L1R
- Produces L1G

3.3.6 Evaluation & Analysis Subsystem (E&A)

E&A supports the Analyst in evaluating and analyzing the performance of the ETM+ instrument and assisting the analyst in anomaly resolution. The following identifies the processing provided by E&A:

- Utilities to view radiometric and geometric processing inputs, intermediate products and results
- Capability to perform "what if?" analysis
- Creation and update of trending data
- Generation of analysis reports
- Transfer of the generated reports to the DMS
- Requests for update of CPF to DMS

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Section 4. Operational Scenarios

4.1 Introduction

The purpose of this section is to provide an overview of the operational activities expected to be performed in support of IAS.

4.2 User Operations

There are three types of users: operator, radiometric analyst, and geometric analyst. The analysts refine their knowledge about the instruments onboard the spacecraft. The operator supports the analysts by processing image data used in the calibration activity and by monitoring the system.

In addition to typical activities performed over a single day, there are specific activities required during a calibration period. The following subsections identify the activities performed by the analyst and operator for a typical day and over a calibration period.

4.2.1 One-Day-In-Life of IAS

The following are the activities performed by the analyst:

- Examines completed WOs pending analysis review
- Performs analysis on completed WOs
- Examines WOs pending for intermediate action
- Refines intermediate results in WO
- Reviews new anomaly reports
- Requests data for anomaly resolution
- Submits WO for anomaly resolution
- Submits WO for science investigation

The following are activities performed by the operator:

- Examines list of WOs pending for image product
- Orders data from DAAC to satisfy pending WOs
- Monitors execution of WOs
- Monitors system resources
- Generates data acquisition requests for calibration needs
- Copies archived WOs

- Generates ephemeris requests
- Generates calibration parameters file for distribution
- Ingest DAAC files from LPS tar tape
- Restore deleted 0R product

4.2.2 Calibration Period

The following are the activities performed by the analyst and operator at the initial, intermediate, and final phases of a calibration period:

- Initial (at start of a calibration period)

  – Operator generates set of WOs with completion dates for specific processing schemes over a 90-day period

- Intermediate

  – Operator examines those WOs pending for image product
  – Operator requests image product for pending WOs
  – Analyst analyzes results from those WOs associated with calibration

- Final (at end of a calibration period)

  – Analyst gathers data from calibration period
  – Analyst determines if an update to the CPF is needed
  – Analyst generates CPF
  – Analyst verifies updated calibration parameter by submitting WOs on input data using updated CPF

4.3 System Operations and Processing Scenarios

The system operations and processing scenarios present the sequences in which processes are performed by the system or the operations (operator or analyst) personnel. The scenarios are divided into the categories of system setup, normal operations, and anomaly investigation. A description of each category is as follows:

- System Setup - activities involved in IAS initialization and configuration

  – Ingest Pre-Launch Data
  – Define Standard Processing Procedures
  – Setup Report Generation Scripts
  – Startup System

- Normal Operations - activities performed routinely to accomplish Landsat 7 data processing within the IAS

  - Setup WO
  - Ingest L0R
  - Ingest MOC Files
  - Ingest LPGS Files
  - Process WO
  - Review Processing Results
  - Perform Calibration
  - Generate Calibration Parameter File
  - Transfer MOC Files
  - Transfer DAAC Files
  - Transfer LPS File
  - Delete Data
  - Recover L0R

- Anomaly Investigation - activities involved in resolving anomalies

  - Rerun WO

4.4 System Setup

System setup operations scenarios describe the sequences of user activities involved in IAS initialization and configuration.

4.4.1 Startup System

The operator brings IAS from a system boot state by the following steps:

Step	Agent	Action
1	Operator	Log into work station
2	Operator	Start up the main UI window on the work station
3	Operator	Modify configuration parameters
4	Operator	Initialize the IAS
5	PCS	Start up the kernal tasks

4.4.2 Shutdown System

The operator brings IAS from a system boot state by the following steps:

Step	Agent	Action
1	Operator	Request shutdown of IAS
2	PCS	Notify kernel tasks to start shutdown

4.5 Normal Operations

Normal IAS operations scenarios describe the sequences of user activities performed routinely to accomplish Landsat 7 data processing within the IAS.

4.5.1 Setup Work Order

The steps for creating a new WO are as follows:

Step	Agent	Action
1	Operator	Log onto DAAC
2	Operator	Browse DAAC for applicable image product
3	Operator	Order image product
4	Operator	Create WO for selected image product (specify processing procedure)
5	Operator	Specify override for default processing parameters
6	Operator	Submit WO

4.5.2 Ingest L0R

The L0R product comes to the IAS either by network or tape.

4.5.2.1 Ingest L0R via Network

Receipt of L0R via network from DAAC to the IAS occurs automatically. This section describes the automatic ingest scenario. The steps performed to ingest L0R from the DAAC are as follows:

Step	Agent	Action
1	DAAC	DAAC Send a DAN for a L0R to IAS
2	DMS	Receive a DAN from the DAAC for L0R
3	DMS	Create an image directory for L0R
4	DMS	Ftp the files associated with the L0R into image directory
5	DMS	Verify the image product for consistency and quality
6	DMS	Correct PCD and MSCD
7	DMS	Create Data Directory Record (DDR)
8	DMS	Output Trending Data
9	DMS	Generate Ingest Report
10	DMS	Locate WO(s) requesting image product
11	DMS	Catalog image product

4.5.2.2 Ingest L0R via Tape

Receipt of L0R via tape from DAAC occurs manually. This section describes the manual ingest scenario. The steps performed to ingest L0R from the DAAC are as follows:

Step	Agent	Action
1	DAAC	Send a tar tape
2	Operator	List the tar tape contents to verify tape
3	Operator	Create 0R directory on product partition
4	Operator	Un-tar the tape to the 0R directory
5	Operator	Start up the utility to send the “start ingesting tape” command to the DMS
6	DMS	Receive “start ingesting tape” command
7	DMS	Verify the image product for consistency and quality
8	DMS	Correct PCD and MSCD
9	DMS	Create Data Directory Record (DDR)
10	DMS	Output Trending Data
11	DMS	Generate Ingest Report
12	DMS	Locate WO(s) requesting image product
13	DMS	Catalog image product

4.5.3 Ingest MOC Files

Receipt of reports and ephemeris data files from the MOC to the IAS occurs automatically. This section describes the automatic ingest scenario. The steps performed to ingest files from the MOC are as follows:

Step	Agent	Action
1	MOC	Ftp a file to designated directory in IAS
2	DMS	Detect file in the MOC ingest directory
3	DMS	Move file to its permanent location
4*	DMS	Convert the ephemeris file into binary UNIX format
5*	DMS	Catalog the ephemeris file

* Optional

4.5.4 Ingest LPGS Files

Receipt of files from LPGS is TBD. This section describes the ingest LPGS files scenario. The steps performed to ingest LPGS files are as follows:

Step	Agent	Action
1	LPGS	
n		

4.5.5 Process Work Order

The initiation of a WO occurs automatically when an ingested L0R is associated with a WO. The steps for processing a WO are as follows:

Step	Agent	Action
1	DMS	Notify PCS on arrival of image product from DAAC
2	PCS	Retrieve WOs that are ready to start
3	PCS	Check system resources to see if the WO can run
4	PCS	Start a task to process the WO
5	PCS	Monitor the WO
6	PCS	Detect WO requested halt state
7	PCS	Notify analyst for action on WO
8	Analyst	Get list of WOs requiring action
9	Analyst	Select WO for intermediate action
10	Analyst	Change the WO parameters and resume processing or terminate the WO
11	PCS	Repeat steps 5 through 10 for next script unless no next script is detected
12	PCS	Notify analyst of the completion of the WO

4.5.6 Review Processing Results

Scenarios for reviewing processing results are to be supplied (TBS).

4.5.7 Perform Calibration

Scenarios for performing calibration are TBS.

4.5.8 Generate Calibration Parameter File

The generation of CPF is done automatically after the analyst have decided that the geometry and radiometry updates are correct. The steps for generating a CPFe are as follows:

Step	Agent	Action

Step	Agent	Action
1	Analyst	Review the geometry CPF
2	Analyst	Update the geometry CPF
3	Analyst	Review the radiometry CPF
4	Analyst	Update the radiometry CPF
5	Analyst	Start up utility to merge the geometry and/or radiometry CPF changes into one file
6	DMS	Parse the geometry CPF
7	DMS	Parse the radiometry CPF
8	DMS	Parse the base line CPF
9	DMS	Merge the changes together
10	DMS	Print out the new CPF
11	DMS	Update database with new CPF statistics
12	Analyst	Review the new CPF

4.5.9 Transfer Files

This section contains the scenarios for transferring files from the IAS to external interfaces.

4.5.9.1 Transfer MOC Files

The transfer of files from IAS to the MOC occurs automatically. The following scenario describes the step performed to initiate the transfer and the system steps that automatically transfer files to the MOC.

Step	Agent	Action
1	Analyst	Generate MOC request
2	DMS	Detect request for data transfer
3	DMS	Obtain location of data file and destination
4	DMS	Connect to target host
5	DMS	Ftp the file

4.5.9.2 Transfer DAAC Files

The transfer of files from IAS to the DAAC requires user and system interaction for transfer. The following scenario describes the steps necessary to cause files to be transferred to the DAAC:

Step	Agent	Action
1	Analyst	Generate IAS report
2	Analyst	Generate CPF
3	DMS	Detect request for data transfer
4	Operator	Specify filename and location of DAAC file
5	DAAC	Retrieve file as specified by IAS

4.5.9.3 Transfer LPS Files

The transfer of files from IAS to the LPS requires user and system interaction for transfer. The following scenario describes the steps necessary to cause files to be transferred to the LPS:

Step	Agent	Action
1	Analyst	Generate CPF
2	DMS	Detect request for data transfer
3	Operator	Inform LPS of file availability
4	LPS	Retrieve file from IAS

4.5.10 Delete Data

Data deletion of intermediate files created during the processing of a WO or image product occurs automatically. Prior ro deleting intermediate files, IAS will archive the files to a tape.

4.5.10.1 Delete WO

The following scenario identifies the steps for automatically deleting a WO:

Step	Agent	Action
1	Analyst	Specify a WO as analyzed
2	DMS	Determine WO scheduled for deletion
3	DMS	Archive intermediate file to staged directory
4	DMS	Delete directory for WO
5	Operator	Obtain list of archived WOs
6	Operator	Specify tape volume for receiving archived WO data
7	DMS	Copy archived files to tape
8	DMS	Delete archived WOs
9	DMS	Record tape volume for archived WOs

4.5.10.2 Delete Image Product

The following scenario identifies the steps for automatically deleting a 0R product:

Step	Agent	Action
1	Analyst	Specify WO as analyzed
2	DMS	Determine which image product has passed the expiration date and is not in use by a WO
3	DMS	Delete directory for image product

4.5.11 Recover L0R

The following scenario identifies the steps for manually recovering a L0R:

Step	Agent	Action
1	Operator	The operator lists the tar tape to verify that the tape contents is an ingested L0R product
2	Operator	Un-tar the tape to the 0R directory
3	Operator	Start up a utility to change the L0R's delete flag to "not deleted"
4	DMS	Update L0R's delete flag to "not deleted"

4.6 Anomaly Investigation

Anomaly investigation scenarios describe the sequences of user activities performed to resolve anomalies detected in IAS or LPGS.

4.6.1 Rerun Work Order

The steps for rerunning a WO are as follows:

Step	Agent	Action
1	Analyst	Determine to rerun a WO
2	Analyst	Replicate WO (and copy intermediate files)
3	Analyst	Modify input parameters for new WO
4	Analyst	Modify intermediate file(s)
5	Analyst	Specify starting place in new WO
6	PCS	The PCS retrieves the WO specification from the database

4.7 Typical End-to-End Scenario

There are eight types of images each with their unique processing procedure. The end-to-end processing scenario is essentially identical for any type of image. The following steps are performed to process an image:

Step	Agent	Action
1	Operator	Obtain list of data requests for open WOs
2	Operator	Review DAAC holding that satisfy data requests
3	Operator	Browse data for applicability at IAS
4	Operator	Order data for processing at IAS
5	DAAC	Provide invoice number for requested data
6	Operator	Obtain time span of data request for FDF data
7	Operator	Generate data request for concentrated ephemeris

Step	Agent	Action
8	DMS	Send data request to MOC
9	Operator	Update WO with invoice number (Create L1R using PCD; create L1G using FDF data)
10	Operator	Override default parameters for WO
11	MOC	Send concentrated ephemeris (received from FDF)
12	DMS	Detect arrival of ephemeris data from MOC
13	DMS	Convert ephemeris data to local format
14	DMS	Catalog converted ephemeris data
15	MOC	Send report(s)
16	DMS	Detect arrival of report from MOC
17	DMS	Move report to report directory
18	DAAC	Send a DAN for requested data
19	DMS	Retrieve files from DAAC as specified in DAN associated with a invoice number
20	DMS	Verify consistency and quality of retrieved files
21	DMS	Correct PCD
22	DMS	Correct MSCD Locate
23	DMS	WO for verified data associated with invoice number
24	DMS	Update WO with filename
25	PCS	Identify WO ready for processing
26	PCS	Verify sufficient system resources for WO
27	PCS	Submit WO for processing
28	GPS	Initialize ETM+ model
29	RPS	Process L0R to L1R (L1R Processing)
30	GPS	Generate L1Gs image
31	GPS	Perform **(GCS)** correlation
32	PCS	Indicate WO pending analyst's action
33	Analyst	Obtain list of WOs pending interactive analysis
34	Analyst	Iterate on precision solution
35	Analyst	Notify resumption of WO
36	PCS	Identify WO ready for resumption
37	GPS	Update ETM+ model
38	GPS	Generate L1G image
39	PCS	Indicate WO pending evaluation & assessment
40	Analyst	Obtain list of completed WOs
41	Analyst	Assess accuracy of geometric WO
42	Analyst	Generate geometric accuracy report
43	Analyst	Notify analysis status for completed of WO
44	DMS	Archive intermediate files for analyzed WO
45	DMS	Delete files associated with analyzed WO

4.8 Contingency Operations

REVIEW

Contingency operations scenarios describe the sequences of operator activities performed to handle abnormal conditions during IAS processing. Abnormal conditions include software failures and storage capacity short falls.

Scenarios for contingency operations are TBS.

Section 5. Global Routines

5.1 Introduction

The IAS will use global routines to implement communication among subsystems and common functionality in different subsystems. The global routines also contain non-POSIX compliant software that needs to be isolated for future software porting purposes.

5.2 Design Overview

This section provides an overview of the global library design, as well as a discussion of the considerations used in the design process.

5.2.1 Library Overview

As mentioned before, the global routines are those candidates that either the functions shared by IAS subsystems or the functions are non-POSIX compliant that need to be isolated for future software porting purposes.

5.2.2 Design Considerations

This subsection presents the design drivers relevant to the global library software design. The following describes the major assumptions or considerations that influenced the design of the global library software:

- The design of all the global library routines keeps the AP interfaces (API) to a minimum. On the other hand, the APIs from the global libraries to the operating system will be transparent when the global functions are implemented.
- Each global function has its own structure chart and is invoked by the subsystems.
- The naming convention follows IAS software naming convention prefixed with 'xxx' as global identification.
- The global functions are responsible for releasing any memory allocated within the global function. The one exception to this rule occurs when RPS/GPS call xxx_GetParm to retrieve an array of character strings

5.3 Library Design

There are five categories of IAS global routines: WOrkOrder, Database, LOR, inter-process communication (IPC), and system. The following table provides an alphabetical listing of the global routines plus their functional description.

Function Name	Global library category	Functional Description
xxx_CloseImagery	L0R	Close an LOR band file
xxx_CloseUnmap	System	Close and optionally unmap a file
xxx_Commit	Database	Commit all database changes
xxx_ConnectToDB	Database	Connect to the IAS database
xxx_DisconnectFrom DB	Database	Disconnect from the database
xxx_FileLock	System	Lock/Unlock a file
xxx_GetEphemeris()	WorkOrder	Retrieve ephemeris vector for a given time. Ephemeris can be either PCD, definitive, or concentrated
xxx_GetParm	WorkOrder	Retrieve an input parameter's value. The user provides the storage location for the value. The function retrieves the value from the program's input ODL file of parameters and converts the value to the user defined data type.
xxx_GetTempName	System	(non-Posix) create a name for a temporary file
xxx_GetTime	System	Create a data/time stamp
xxx_HexDump	System	Dump the specified memory contents into an ASCII hex string
xxx_ipc_accept	IPC	Accept a socket connection with a client
xxx_ipc_client	IPC	Connect to a server rendezvous port and establish a socket connection with the server
xxx_ipc_close	IPC	Close a socket
xxx_ipc_clr	IPC	Clear a socket descriptor from the 'select' array
xxx_ipc_isset	IPC	Check if a socket descriptor in the 'select' array is set. If set, this indicates a socket has data and is ready to be read.
xxx_ipc_read	IPC	Read the message from the socket
xxx_ipc_select	IPC	Check for socket activity on all supplied socket descriptors
xxx_ipc_server	IPC	Define the server's rendezvous socket

Function Name	Global library category	Functional Description
xxx_ipc_set	IPC	Add a socket descriptor to the ‘select’ array
xxx_ipc_write	IPC	Write a message to a socket
xxx_ipc_zero	IPC	Clear the entire ‘select’ array
xxx_LogError	System	Report error to system log
xxx_LogStatus	WorkOrder	Write the user supplied string to the WO log file.
xxx_OpenImagery	L0R	Open an LOR band file
xxx_OpenMap	System	Open and optionally map a file
xxx_PutEvent	Database	Write an event to the database event log table
xxx_PutTrend	WorkOrder	Write program trending data to the database
xxx_Read0R_Report	L0R	Read the report generated during an L0R product’s ingest
xxx_ReadCPF	L0R	Retrieves a parameter’s value from the CPF
xxx_ReadDAACMetadata	L0R	Read L0R DAAC metadata
xxx_ReadDDR	L0R	Read and return the data description record
xxx_ReadGeo	L0R	Read and return the geo-location table
xxx_ReadImagery	L0R	Read and return an L0R band file
xxx_ReadMetadata	L0R	Read L0R LPS metadata (bands 1->6L or bands 6H->8)
xxx_ReadMSCD	L0R	Read and return the MSCD
xxx_ReadPCD	L0R	Read and return the PCD
xxx_ReadSLO	L0R	Read and return the SLO
xxx_Remap	System	Memory map a different portion of a file
xxx_ResizeFile	System	Truncate a file using the truncate() or ftruncate() system call
xxx_Rollback	Database	Back out all changes since the previous database commit
xxx_Signal	System	Defines a signal handler to catch all signals
xxx_StartProcess	System	fork/exec a program
xxx_TimeConvert	System	Converts a time from one time format to another
xxx_UserAlarm	WorkOrder	Write an event to the database event log
xxx_WriteImagery	L0R	Write the L0R band to disk
xxxAddAfter	System	List pkg: Add a node after an existing node in a list
xxxAddBefore	System	List pkg: Add a node before an existing node in a list
xxxAddHead	System	List pkg: add a node to head of list

Function Name	Global library category	Functional Description
xxxAddSorted	System	List pkg: Add a node to the list in sorted order
xxxAddTail	System	List pkg: add a node to the tail of the list
xxxAllocCopy	System	List pkg: Allocate memory, then copy value(s) to it
xxxAllocList	System	List pkg: Allocate and initialize a link list
xxxFindNode	System	List pkg: Search list for specific node contents
xxxFreeList	System	List pkg: Free a linked list with no duplicate entries
xxxFreeListDuplicate	System	List pkg: Free a linked list with duplicate entries
xxxListCat	System	List pkg: Concatenate a list with another list
xxxListCount	System	List pkg: Count the nodes in a list
xxxListSort	System	List pkg: Sort a linked list using a supplied sort function
xxxNextNode	System	List pkg: Find the node in the list after the specified node
xxxPrevNode	System	List pkg: Find the node in the list prior to the specified node
xxxRemHead	System	List pkg: Remove a node from the head of a list
xxxRemNode	System	List pkg: Remove the specified node from the list
xxxRemTail	System	List pkg: Remove a node from the tail of a list

Each global routine category is a separate section of the global library. The following subsections provide a brief description of the five sections including the section's global routines.

5.3.1 Work Order

The WO global routines are intended for use by radiometric and geometric software. The routines are used to retrieve WO setup information and report WO status/summary.

5.3.1.1 Retrieve Input Parameter

The xxx_GetParm() function retrieves the user specified parameter from the WO input ODL file. xxx_GetParm will convert the parameter value from the ODL file's ASCII format into the user specified data type. The user also must specify the location (and size) where the converted parameter is to be written.

The ODL file of input parameters is typically created by the WO controller task (PWC) and then passed to the WOS via a command line parameter. The WOS in turn passes the ODL filename to the radiometric/geometric program as a command line parameter. These programs must define the ODL filename as a global variable prior to calling xxx_GetParm(). When WOs are run outside IAS (i.e., PWC does not build the ODL file), the user can reuse an ODL file from a previously executed WO.

Figure 5-1 shows the xxx_GetParm() structure chart.

5.3.1.2 Send User Alarm

When an application process encounters a severe error requiring attention from the operator, it will call the xxx_UserAlarm() function to forward the error to the user's attention. xxx_UserAlarm() will record the error message in the database. On request, the user interface will display all active user alarms written to the database.

However, when an application process is run outside the IAS PCS, the xxx_UserAlarm() will call the xxx_LogStatus() to report the alarm to standard output.

Figure 5-2 shows the xxx_UserAlarm() structure chart.

5.3.1.3 Report Program Status

Application processes will report their status to standard output. When a WO is run inside IAS, standard output is redirected to the WO log file. The xxx_LogStatus() function allows the application process to write a formatted message to standard out that contains the process name, process id, function name, function line number, time, and message. This standardized message output will facilitate the querying of the WO log file via Unix shell language commands.

Figure 5-3 shows the xxx_LogStatus() structure chart.

5.3.1.4 Output Trending Data

Application processes will output trending data for use by the E&A. To output a trending parameter's value, the application process will call xxxPutTrend(). xxx_PutTrend() writes the trending data to an ASCII file or the trending database depending on whether the program is running outside or inside IAS PCS.

xxx_PutTrend() accepts the trending input data as a variable length argument list and passes this list to either the user-supplied stored procedure or a function that generates the ASCII output. The disadvantage to this design approach is that no function prototype checking for xxx_PutTrend (or stored procedure calls) can be performed at compile time. The advantage to this design is that one global function can be written for all IAS (xxx_PutTrend()) instead of a specific function(s) for each RPS/GPS program.

Figure 5-4 shows the xxx_PutTrend() structure chart.

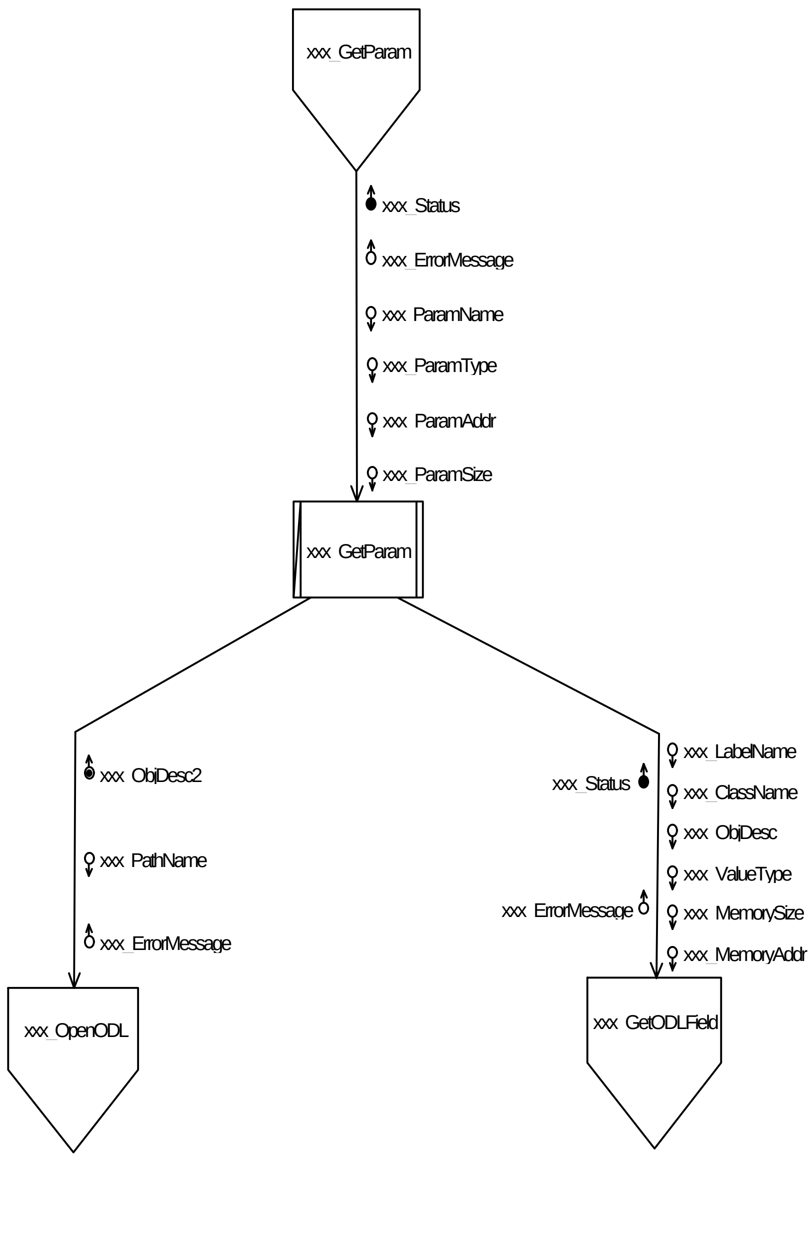

Figure 5-1. xxx_GetParm Structure Chart.

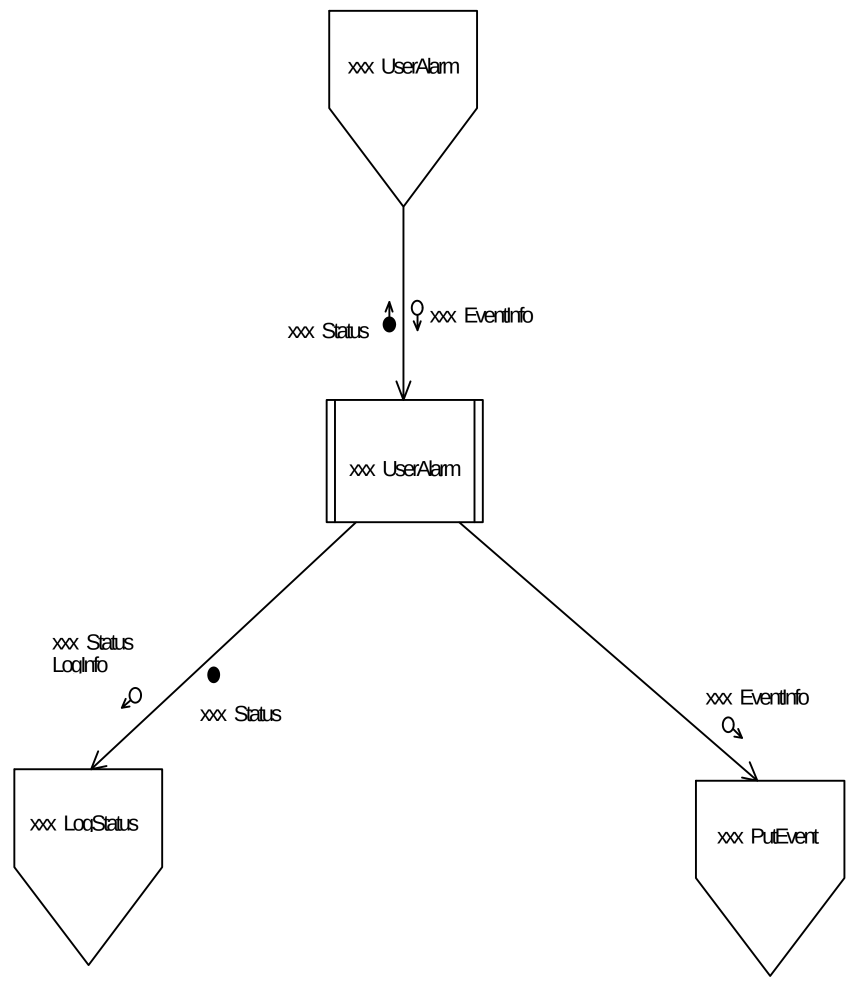

Figure 5-2. xxx_UserAlarm Structure Chart.

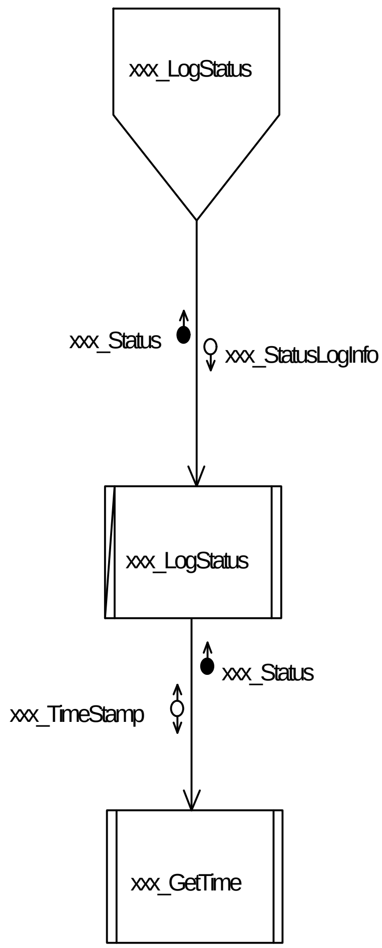

Figure 5-3 xxx_LogStatus Structure Chart

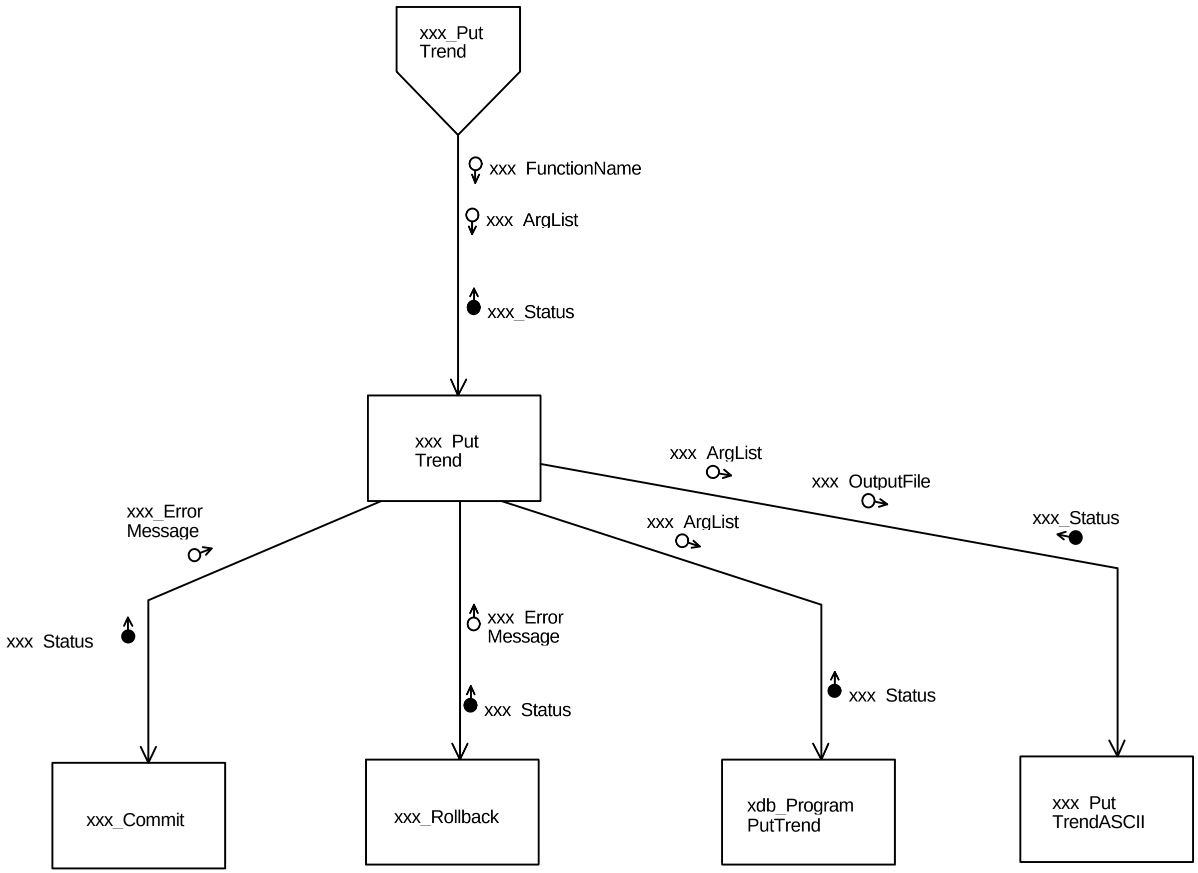

Figure 5-4. xxx_PutTrend Structure Chart.

5.3.1.5 Ephemeris Data Retrieval

The xxx_GetEphemeris() function retrieves ephemeris data (position and velocity vectors) for a given date/time. xxx_GetEphemeris() retrieves the ephemeris data from either the PCD file, FDF definitive ephemeris, or FDF concentrated ephemeris file based on the ephemeris file type WO parameter. xxx_GetEphemeris() retrieves the ephemeris file type via a call to the xxx_GetParm global function.

xxx_GetEphemeris() uses Lagrange interpolation for interpolating PCD ephemeris because the PCD interpolation points are not necessarily a fixed distance apart. xxx_GetEphemeris() uses Hermitte interpolation for interpolating with FDF concentrated or definitive ephemeris.

Figure 5-5 shows the xxx_GetEphemeris() structure chart.

5.3.1.6 Initialize IAS Global Functions

Several IAS global functions require initialization (e.g., global variable definition/population, database connection). It is required for the RPS and GPS tasks to call xxx_Init() to perform this initialization. xxx_Init() will connect to the database only if the WO is running inside the PCS.

5.3.1.7 Close out IAS Global Functions

Several IAS global functions require a termination function to close files, free memory, and/or disconnect from the database. To perform this termination function, RPS and GPS tasks should call xxx_Exit() prior to exiting. It is not required for xxx_exit() to be called prior to exiting. If xxx_exit() is not called prior to exiting, then the programmer may find that run-time analysis tools may report that files are not being closed (these are read-only files), memory is not being freed and/or the database connection was not closed (although no database transaction is left open). WO global units were designed in this fashion to speed up processing.

5.3.2 Database

The RPS and GPS software will not call the global database routines directly. However, some global routines call global routines that interact with the database. Database global functions are used to connect/disconnect from the database or rollback/commit a database transaction. In addition the xxx_PutEvent() unit is available to all IAS tasks to write an event to the IAS event log.

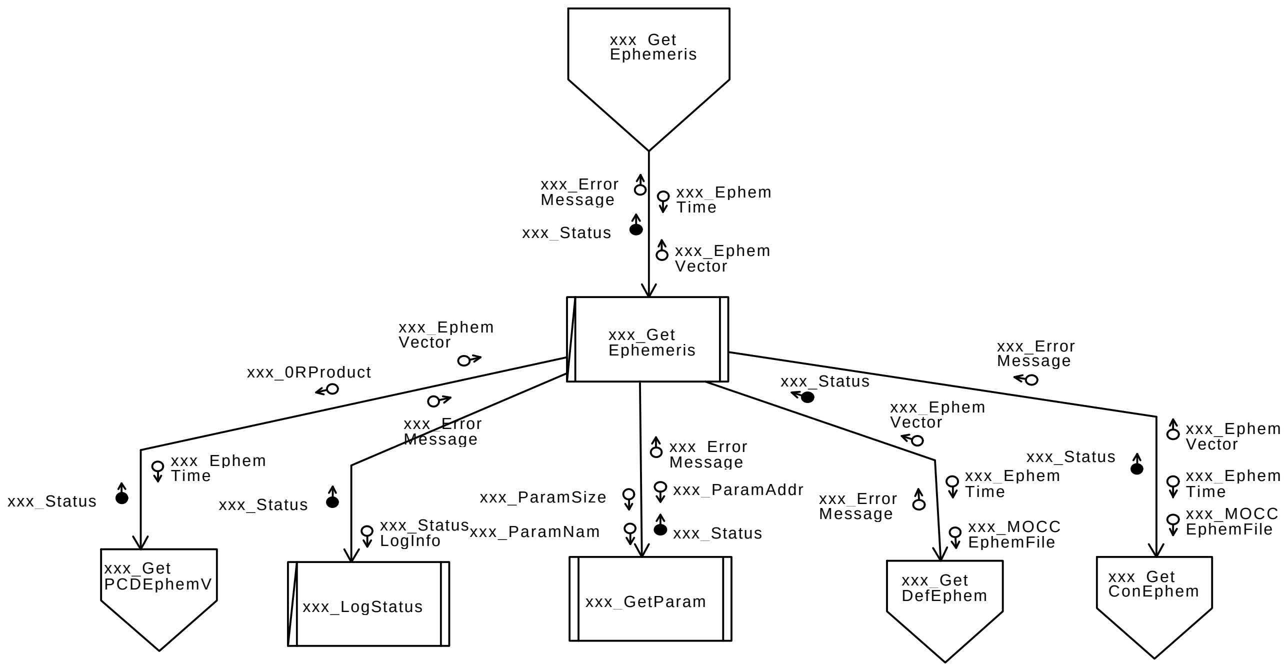

Figure 5-5. xxx_GetEphemeris Structure Chart.

5.3.3 Interprocess Communication (IPC)

Socket IPC is achieved through the global functions that are prefixed with “xxx_ipc." These functions are used by the client and server process to communicate over a TCP socket. These functions are intended to be used to implement the socket connection with the DAAC.

5.3.4 Level 0R Input/Output

L0R input and output is achieved via the L0R global routines. These routines are used to read/write a band file or read the PCD, MSCD, CPR, DDR, metadata, SLO, or geo-location table.

5.3.5 System

System global routines perform miscellaneous functions such as: memory mapped I/O, link list I/O, and file locking. They are not intended for use by the GPS and RPS.

Section 6. Process Control Subsystem

6.1 Introduction

The Process Control Subsystem (PCS) is responsible for starting, controlling, and monitoring WO execution. This section describes the detailed software design for the PCS.

6.2 Design Overview

This section provides an overview of the PCS software design. The relationship between the PCS and other IAS subsystems is presented, along with a discussion of the assumptions, constraints, and considerations used in the design process.

6.2.1 Subsystem Software Overview

Figure 6-1 contains the PCS context diagram. The PCS is responsible for starting, controlling, and monitoring a WO. The PCS communicates with other IAS subsystems via the IAS database. The User Interface (UI) and Data Management Subsystem (DMS) populate the IAS database with WO setup information. The operator enters WOPs, associated scripts, script input parameters, and WO image id(s). The DMS reports the ingested data files (e.g. 0R product) on disk and their processing status. The PCS starts a WO and reports the WO execution status to the IAS database.

The PCS starts a WO after all input files for a WO are successfully ingested and the system resources are available. To start a WO, PCS executes the RPS and GPS programs specified in the WO. PCS builds an ODL file of RPS/GPS program parameters and passes the ODL filename to the RPS/GPS program as a command line argument. As each script completes, PCS reports its completion status to the IAS database. PCS provides for suspension of a WO execution after a script in the WO completes. When a WO is halted, the PCS polls the database looking for the analyst’s response. The PCS resumes WO execution at the analyst specified continuation point. The PCS notifies the analyst when WO processing is complete and ready for assessment. After the analyst completes the WO assessment, the WO output is archived and deleted.

6.2.2 Design Considerations

This subsection presents the design drivers relevant to the PCS software and the assumptions of the software design.

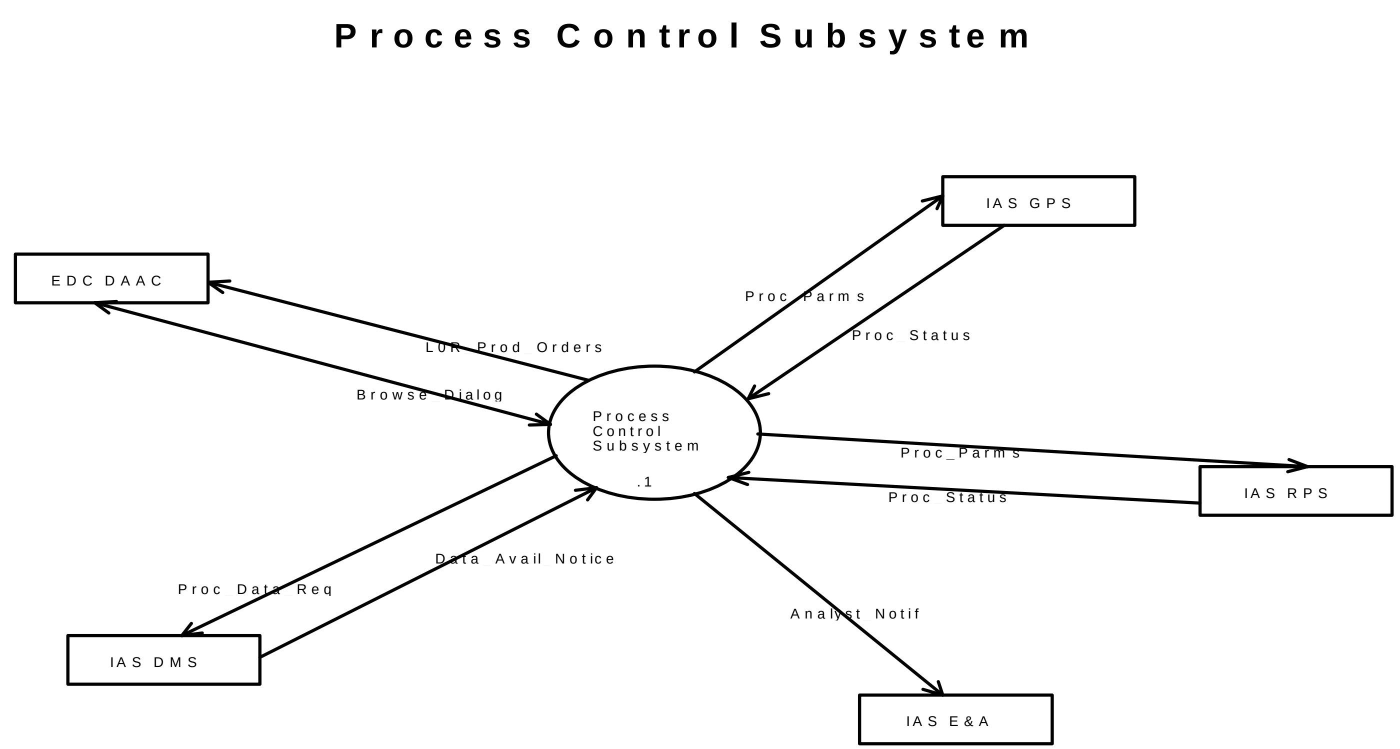

Figure 6-1. PCS Context Diagram

6.2.2.1 Assumptions

The following assumptions were made in designing the Process Control Subsystem:

A. User Response to WO Halt

When a WO is halted, the user can continue the WO at either the next scheduled script, previous script or future script in the WO. If continuation is at a previous script, then all scripts between the continuation and halt position in the WO will be rerun. If continuation is at a future script, then all scripts between the continuation and halt position in the WO are marked as skipped.

B. Parallel WOS Execution

WOSs can not run in parallel.

C. WOS Input Parameters

Application program parameters are passed into each program via an ODL file. The ODL file is created by the PWC task prior to starting the WOS. PWC builds the ODL parameter file based on the WO parameter values retrieved from the database. PWC passes the ODL filename to the WOS which in turn passes the ODL filename as a command line argument to the application program. The application programs retrieves parameter values via a call to the xxx_GetParam global routine.

To run a WO outside the IAS system, the user must copy the ODL file used in an actual WOS execution. Then the user merely runs the script supplying the ODL filename as the first argument to the script.

D. WOS Contents

All application programs are unique within a WOS. Or, if the same application program is run twice within a script, then the program will have the same input parameter values for both runs.

E. WO Output File Ownership and Privileges

All files created by a WO will default to group read/write access. These files will be owned by the user who starts the IAS software and not the user who defines a particular WO.

F. WO Default Directory

A WO’s default directory is the local directory when a WO’s scripts are executed. Normally, PCS creates the default WO directory just prior to starting the WO. PCS creates two subdirectories inside the default WO directory, they are named /temp and /save. After the

WO completes, the /temp directory is deleted and the /save directory is moved to a "tar" directory where it will be archived to tape.

A WO's intermediate files are those files whose names are not defined as a WO input parameter. During anomaly investigation, one WO's intermediate files may be needed as input to another WO. In this scenario, a user can use the UI to define the WO's default directory and copy intermediate files from a prior WO into the WO's default directory.

G. Memory Management

The IAS is assumed to have 2 GB of real memory and 21 GB of virtual memory. The PCS will be designed to only allow a configurable number of WOs to run simultaneously. This design feature is a precaution against the unlikely scenario of the IAS running out of virtual memory or having excessive process swapping. When more than the configurable limit of works orders are ready to run, the PCS will use a user assigned priority to select the WO to run.

6.2.2.2 Subsystem Support of Operational Scenarios

Table 6-1 maps the PCS-related operational scenarios to the supporting tasks. These scenarios are presented in Section 4 of this document.

Table 6-1. PCS-related Operational Scenario *s*

Operational Scenario	Support Level
Startup System	Major
Shutdown System	Major
Process WO	Major
Rerun WO	Major

6.2.2.3 Software Reuse Strategy

This subsection identifies external components that may be reused by the PCS as well as components of the PCS software that may be useful to other IAS subsystems.

- Some database modules will be reused from the Pacor II system.
- The lablib software will be used for reading, parsing, write, etc. the ODL files.

6.3 Subsystem Design

This subsection provides a detailed description of the PCS software task model selected to implement the PCS design. Figure 6-2 presents the PCS task model. The PCS is comprised of the Startup IAS Software (PSI), WO Scheduler (PWS), and WO Controller (PWC) tasks. The PSI and PWS tasks

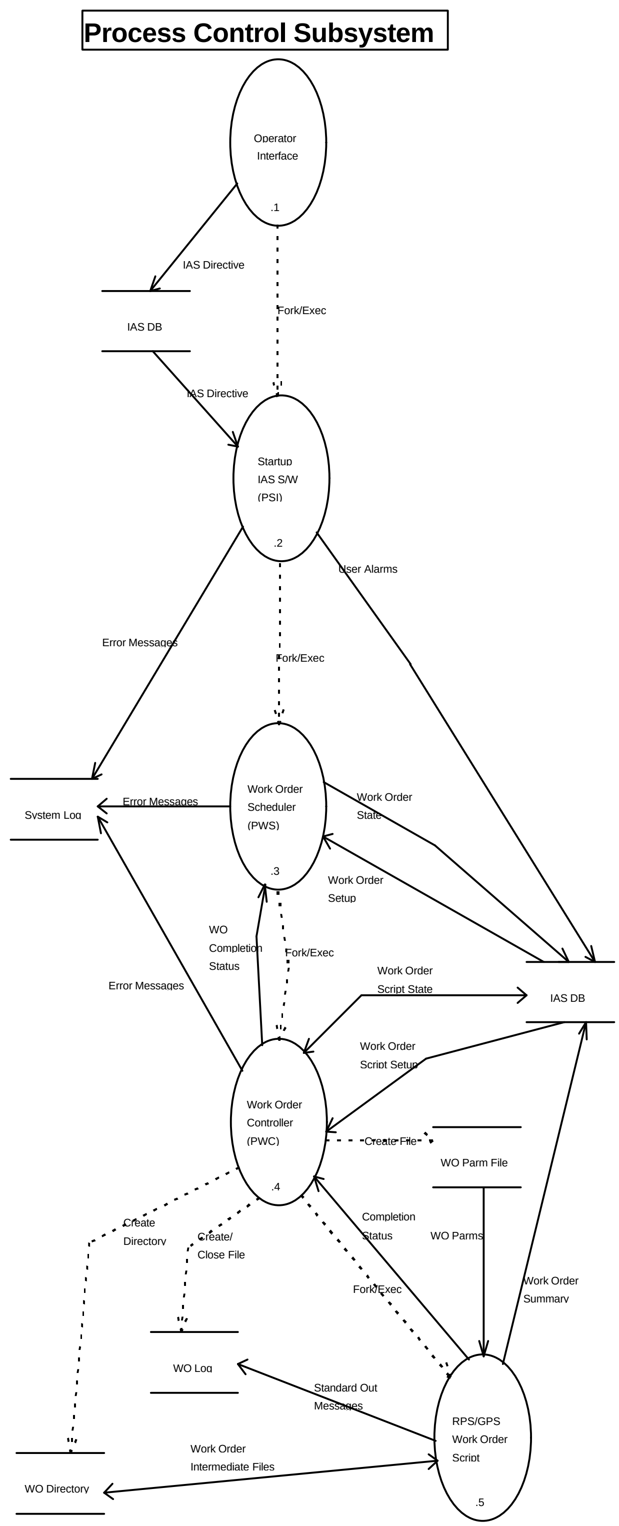

Figure 6-2. PCS Task Model

run in the background at all times. The PSI task starts and monitors all IAS background tasks. The PWS task is responsible for polling the database to determine when to start a WO. To start a WO, the PWS task performs a fork and exec of the PWC task. PWS also reports the start/stop state of every WO to the IAS DB. The PWC task is responsible for building the WO execution environment, starting each WOS, monitoring script termination and reporting WOS status.

The key objective used in the task-level design was to identify the primary services required of PCS software and to evaluated their implementation as sequential or concurrent activities relative to each other. The three tasks (PSI, PWS, and PWC) were selected as candidates for implementation as concurrent processes.

The description of each task is persented in the following subsections. The description consists of the intialization, normal operation, error handling, and design of the task.

6.3.1 Startup IAS Software (PSI) Task

This subsection describes the PSI software.

6.3.1.1 Initialization

The PSI task initialization consists of starting each of the IAS background tasks. PSI also connects to the database and retrieves task setup information (e.g. database polling interval) and defines a signal handler.

6.3.1.2 Normal Operation

During normal operation, PSI performs in a loop until the operator performs a shutdown. Inside the loop, PSI checks for abnormal child termination and polls the database for any user directives. On an abnormal child termination, PSI reports the event to the database and automatically restarts the failed task (provided the task hasn't already been restarted a configurable number of times).

6.3.1.3 Error Handling

The following list shows the types of errors that PSI may encounter and how PSI will process these errors:

Error	Action Taken
Can't connect to IAS DB	Report error to IAS s/w log and exit process
Can't start child process	Report error and continue
Can't read/update database	Report error and continue

6.3.1.4 Design

This subsection presents the design of the software component (SC) that implements the functions of the PSI task. Figure 6-3 presents the structure chart of the PSI task. The following table identifies the high level input and outputs of the task:.

Input

Data Item	Source	Description
IAS Directive	User Interface / IAS DB	Shutdown/restart IAS task

Output

Data Item	Destination	Description
error text	System log	Detailed error message
Event	IAS DB (Event log)	Major processing event occurred

The following PDL for the unit psi_Main describes the high level programming logic of the task:

```
Call psi_Init() to initialize the task

DOUNTIL shutdown directive received
        Call psi_StartProcess() to start any task(s) marked as “ready to start”
        Call psi_ReapChild() to process terminated child task(s)
    Call psi_ProcDir() to process any new directive
ENDDO

DOUNTIL all child tasks have terminated
    Call psi_ReapChild() to process terminated child task
ENDDO

Call xxx_PutEvent() to report successful IAS shutdown

Call xdb_DisconnectFromDatabase() to disconnect from database
IF database error THEN
    Call xxx_LogError() to log error message
ENDIF

Exit EXIT_SUCCESS
```

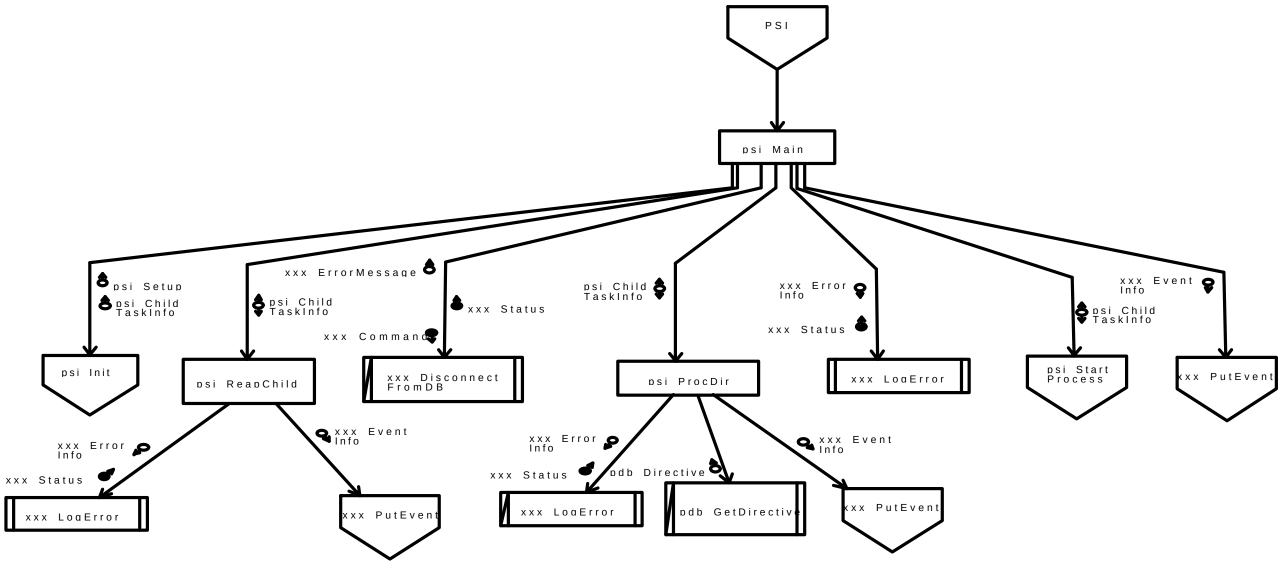

Figure 6-3. PSI-SC Structure Chart

The following table lists all PSI task units and their purpose:

Unit Name	Purpose
psi_Init	Connect to DB and verify no other PSI running
psi_Main	Control the PSI task
psi_ProcDir	Process directive (e.g. shutdown, restart) from user
psi_ReapChild	Process child task termination - alert user if required
psi_StartProcess	Start all IAS tasks which are marked “ready to start”

6.3.2 WO Scheduler (PWS) Task

This subsection describes the PWS task software.

6.3.2.1 Initialization

The PWS task initialization begins by connecting to the database and retrieving setup parameters. Next, a signal catcher is defined to catch and report a Unix signal.

6.3.2.2 Normal Operation

During normal operation, the PWS performs in a loop until the operator manually kills the task. Inside the loop the PWS task calls two functions (pws_GetStartableWO and pws_ReapChild) and then sleeps for a configurable amount of time. The first function (pws_GetStartableWO) retrieves the WOs that can be started. For each WO to start, pws_GetStartableWO calls pws_StartWorkOrder() to start a PWC child task which is responsible for executing the WO. The pws_GetStartableWO can start a WO if all referenced image and ephemeris files are successfully ingested and the number of active WO's is below a configurable limit (e.g. only 4 active WOs at any one time). The second function (pws_ReapChild) checks for terminated PWC child tasks and reports the termination status to the database.

6.3.2.3 Error Handling

The following list shows the types of errors that PWS may encounter and how PWS will process these errors:

Error	Action Taken
Abnormal child termination	Set WO state to “abnormally terminated” and report error
Can’t Connect to IAS DB	Report error to IAS s/w log and exit process
Can’t read/write IAS DB	Report error to DB and IAS s/w log and (continue or exit depending on error location)
Can’t start child process	Set WO state to “abnormally terminated” and report error

6.3.2.4 Design

This subsection presents the design of the PWS task. Figure 6-4 presents the structure chart of the PWS task. The following tables identify the high level input and outputs of the task.

Input

Data Item	Source	Description
WO Completion State	PWC	Exit state of the PWC task - which PWS uses to update the WO state in the IAS DB
WO Setup	IAS DB	max concurrent WOs and database polling interval

Output

Data Item	Destination	Description
Event	IAS DB (Event log)	Major processing event (e.g. WO start/stop)
System log	IAS disk	Log of IAS s/w errors
WO State	IAS DB	Set WO to "in progress" or "complete" state

The following PDL for the unit pws_Main describes the high level programming logic of the task:

```
Call pws_Init() to initialize the task and retrieve setup information

DOUNTIL task shutdown directive (SIGTERM signal) received
    Call pws_GetStartableWO() to identify startable WOs
    DOFOR each startable WO
          Call pws_StartWorkOrder() to start a PWC task which executes the WO
    ENDDO
    Call pws_ReapChild() to retrieve and report a PWC child task's termination status
    Sleep for a configurable amount of time
ENDDO

DOUNTIL no more PWC child tasks are running
    Call pws_ReapChild() to retrieve and report a PWC child task's termination status
ENDDO

Call xxx_DisconnectFromDB() to disconnect from db
IF error THEN
    Call xxx_LogError() to write error to software log
ENDIF
```
:

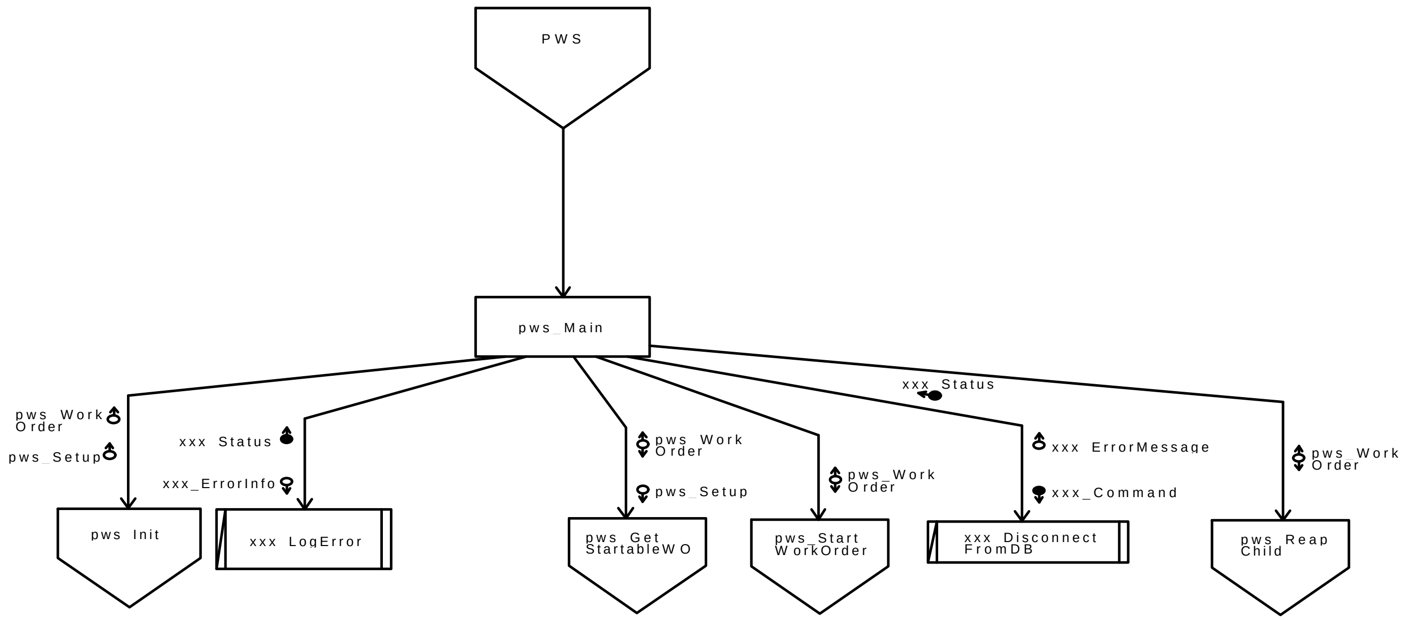

Figure 6-4. PWS SC Structure Chart

The following table lists all PWS task units and their purpose:

Unit name	Purpose
pws_GetStartableWO	Query DB to identify WO(s) to start then insert WO(s) on WO start queue
pws_Init	Connect to DB and retrieve task setup
pws_Main	Control the PWS tasl
pws_ReapChild	Identify and report terminated WOs (i.e. terminated PWC task)
pws_StartWorkOrder	Start PWC task for each WO in queue

6.3.3 WO Controller (PWC) Task

This subsection describes the PWC task.

6.3.3.1 Initialization

The PWC task initialization begins by connecting to the database and retrieving setup parameters. Next, the WO environment is setup. This includes defining the WO default directory (if the user did not specify a default directory), defining an environment variable for WO id, creating the WO log file, and redirecting standard out to the WO log file. A signal catcher is also defined to catch and report a Unix signal.

6.3.3.2 Normal Operation

PWC performs in a loop until the last script in a WO has completed and there are no outstanding halt requests. Inside the loop, pwc_Main calls the pwc_StartNextScript and pwc_MonitorScript functions. pwc_StartNextScript identifies and starts the next script. To start a script, pwc_StartNextScript must build the script's ODL parameter file and start the script (via fork/exec) with the ODL filename as the script's only argument. pwc_StartNextScript also monitors a WO halt condition and detects when the WO is complete. pwc_MonitorScript detects and reports the script termination.

6.3.3.3 Error Handling

The following list shows the types of errors that PWC may encounter and how PWC will process these errors:

Error	Action Taken
Abnormal WOS termination	Report error to IAS DB and system log and put WO in halt state
Can't connect to IAS DB	Report error to system log and exit process
Can't start WOS	Report error to IAS DB and system log and put WO in halt state
Database read/write error	If updating a script state to "in progress" and update fails, then kill task. Otherwise report error to IAS DB and system log and exit task.

6.3.3.4 Design

This subsection presents the design of the PWC task. Figure 6-5 presents the structure chart of the PWC task. The following table identifies the high level input and outputs of the task:

Input

Data Item	Source	Description
pwc_Setup	IAS DB	WO setup info. including: WO parameters, next script to execute, default directory, and ephemeris file name
Script Completion Status	RPS/GPS	Completion status of a WOS

Output

Data Item	Destination	Description
Event	IAS DB (Event log)	Major processing event (e.g. WO start/stop)
System Log	IAS disk	Log of IAS s/w errors
WO Directory (optional)	IAS disk	WO default directory
WO Log File	IAS disk	Log of WO execution
WO Parameter File	RPS and GPS	File of user specified WO parameters stored in ODL format.
WOS State	IAS DB	Identifies WOS's execution state

The following PDL for the unit pwc_Main describes the high level programming logic of the task:

```
Call pwc_Init() to initialize the task

Call pwc_StartNextScript() to start the initial script of the WO

DOUNTIL all scripts have completed and there are no outstanding halt requests
        Call pwc_MonitorScript() to detect and report the script termination
        Call pwc_StartNextScript() to start the next script that is ready
ENDDO

Call xxx_DisconnectFromDB() to disconnect from the database
IF error disconnecting THEN
        Call xxx_LogError() to report error to s/w log
ENDIF
Exit EXIT_SUCCESS
```

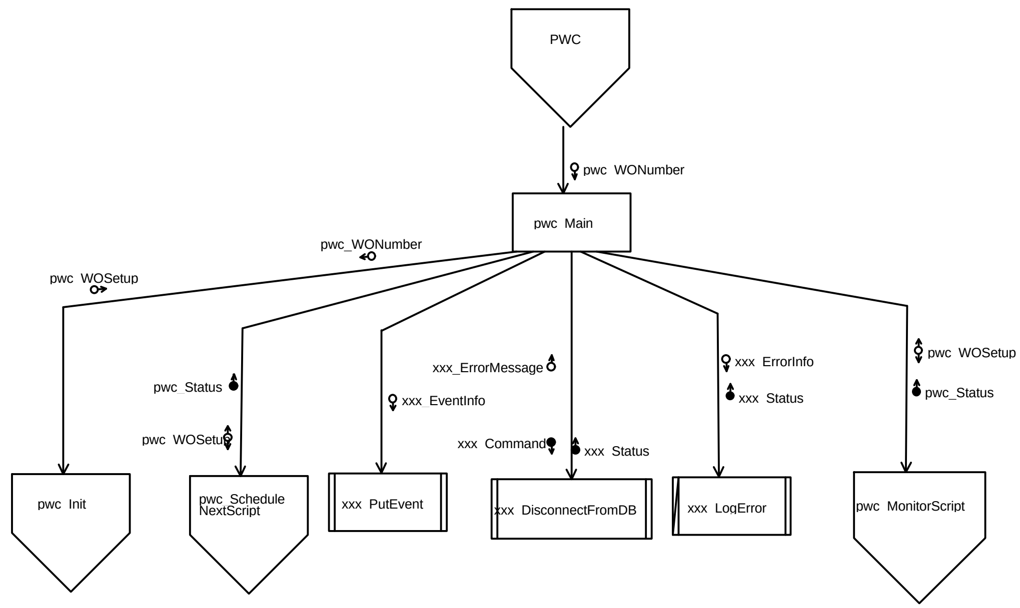

Figure 6-5 PWC Task Design

The following table describes PWC task units and their purpose:

Unit name	Purpose
pwc_Init	Retrieve setup information and build WO environment
pwc_MonitorScript	Identify and report a terminated WOS
pwc_StartNextScript	Identify and start next WOS. Also builds each script's ODL parameter file.
pws_Main	Control the PWC task

6.4 Subsystem Internal Files

This subsection presents a discussion of the structure and format of internal files generated and used by the IAS software.

6.4.1 IAS System log file

The system log file is used by all IAS tasks to record information related to errors or exceptions encountered by the application software. This file is intended as an aid for identifying exceptions encountered by the application software.

6.4.1.1 Naming Convention

The name of the system log file is constructed by concatenating the host name of the machine with the ASCII string "-log". For example, the software log file name for a machine with a host name of ias1 is known to all IAS software takes as "ias1-log".

6.4.1.2 Logical Format and Organization

The system log file is organized as a collection of variable size records, where each record is an ASCII string containing information relevant to the encountered exception. As a minimum each message of record in the log contains the date and time of the exception, the three-letter acronym
of the IAS task that generated the message, the operating system process ID, and the name of the source file including the line number that generated the message. This generic information is then followed by an ASCII message continuing a brief description of the problem along with additional pertinent process-specific information.

6.4.1.3 Physical Format and Organization

This location of the log file is defined in the IAS configuration database table. The file's data is all ASCII with each record terminated by <CR><LF>.

6.4.1.4 File Operations

This subsection describes the operations performed on the system log file.

- File creation - If the file does not exist, the PCS task creates it as part of the application software initialization and writes the header.
- File read - This file is read by any of the IAS software tasks.
- File write - All IAS software tasks can write to the system log file.
- File delete - The IAS software log is not deleted by the IAS software automatically. A system administer will delete or shorten the file as needed.

6.4.1.5 Access Control

All IAS software tasks access this file in a write-only mode. Suitable locks are used by the IAS software tasks to ensure mutual exclusion while accessing the system log file. All other users have read-only access to the software log file.

6.4.2 WO Log

The WO log contains all messages written to standard out by a WO's scripts and application programs. There is a unique WO log for each WO.

6.4.2.1 Naming Convention

The WO log filename will contain the WO id with a ".log" appended to it.

6.4.2.2 Logical Format and Organization

The WO log file is organized as a collection of variable size records, where each record is an ASCII string containing status information about the WO run.
If the global library function xxx_LogStatus is used to write information to the WO log file, then each record in the file will contain the same format. Each record will have the date and time of the message, task name, operating system process id, name of the source file including the line number and the message.

6.4.2.3 Physical Format and Organization

The WO log file is located in the WO default directory. The file's data is all ASCII with each record terminated by <CR><LF>.

6.4.2.4 File Operations

This subsection describes the operations performed on the WO log file.

- file creation - The file is created by PWC prior to starting the first WOS.
- file read - This file is not read by IAS software.
- File write - All WOSs and application programs can write to the WO log file.
- File delete - The WO log file is deleted by the DMS subsystem whenever the WO is deleted.

6.4.2.5 Access Control

All WOSs and application programs access this file in a write-only mode. Suitable locks are used by the xxx_LogStatus global routine to ensure mutual exclusion while accessing the WO log file.

Section 7. Data Management Subsystem

7.1 Introduction

The Data Management Subsystem (DMS) provides file ingest, resource monitoring, file deletion, and file transfer.

7.2 Design Overview

This section provides an overview of the DMS software design that includes relationship between the DMS and other IAS subsystems and a software task model showing the interdependency among DMS software components. In addition, this section identifies the assumptions, constraints and considerations that were used during the design process.

7.2.1 Subsystem Software Overview

Figure 7-1 contains the context diagram of DMS. As shown, DMS interfaces with the DAAC, MOC, LPS and IAS database. The DMS receives the L0R product from the DAAC either electronically or by tar tape; the DMS sends the CPF and reports to the DAAC. The DMS receives ephemeris data and reports from the MOC; the DMS sends data acquisition request, ephemeris request, CPF, and reports to the MOC. The DMS sends CPF to the LPS. The DMS communicates with other subsystems via the IAS database.

Initially, either the DAAC sends a DAN to the IAS when a L0R product is available or the user will start up a utility that will send an ingest start command to the DMS. When DMS receives a DAN, the DMS processes the DAN and retrieves the files listed in the DAN. When a utility is used, the user has already created the L0R directory on the IAS product partition and saved the L0R image there. The utility simply sends a start ingest command to the DMS that causes the DMS to skip the retrieval logic. With the L0R image files now on disk, the DMS performs verification and quality checking on the image product. In addition, the DMS corrects the PCD and MSCD associated with the image product. Once the DMS has preprocessed the image product, it will check to see if any WOs are associate to it.

The MOC sends files to a designated directory in the IAS. The DMS scans this directory periodically for newly arrived files. When DMS detects a new file, it moves the file to an appropriate directory. If the file is ephemeris data, DMS converts it to a binary form for use by GPS.

The DMS polls the IAS database for data transfer request. When it finds a pending transfer request, DMS retrieves the location of the file and the destination facility. Then the DMS sends the file.

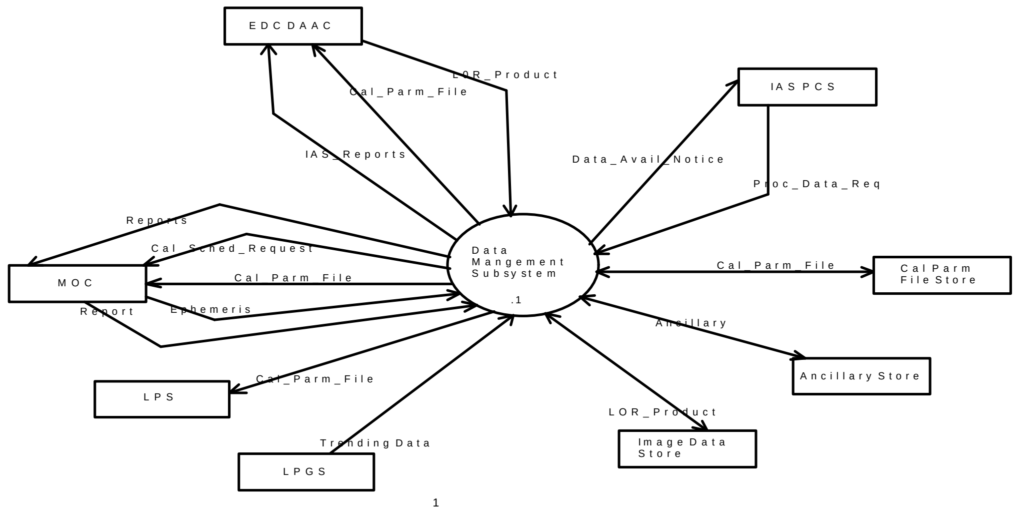

Figure 7-1. DMS Context Diagram

The DMS polls the IAS database for data delete requests. When it finds a pending delete request, DMS first retrieves the names of the WOs for deletion, it then archives the permanent WO files, and then deletes the WO's directory. DMS then retrieves the names of the L0R product identified for deletion and deletes the L0R product's directory. In addition, the DMS also monitors the disks and reports to the operator when a threshold was exceeded.

7.2.2 Design Considerations

This subsection presents the design driver relevant to the DMS software and the assumptions of the software design.

7.2.2.1 Design Assumptions

This subsection presents important assumptions at this point in the design. These assumptions impact software design and remain in effect until notified otherwise.

- When the MOC file size has not increased for a specified time period, the DMS will assume that the file transfer is complete.
- The DMS will receive a DAN message notifying DMS where to retrieve L0R products from the DAAC.
- The DMS will receive tar tapes that contain L0R product in DAAC file format.
- The DMS will not write out any intermediate messages to database while ingesting files from the DAAC or MOC.
- The DMS task will automatically copy files to target facilities.
- The L0R product file name will be unique.

7.2.2.2 Subsystem Support of Operational Scenarios

Table 7-1 maps the DMS-related operational scenarios (Section 4) to the supporting tasks.

Table 7-1. DMS-related Operational Scenarios

Operational Scenario	Support Level
Data Delete	Major
Ingest DAAC files	Major
Ingest MOC files	Major
Transfer Files	Major
Ingest L0R from tar tapes	Major
Recover L0R products	Major

7.2.2.3 Software Reuse Strategy

This subsection identifies external components that may be reused by the DMS as well as components of the DMS software that may be useful to other IAS subsystems.

- The low-level socket management modules and some database modules will be reused from the Pacor II system.

- The lablib software will be used for reading, parsing, write, etc. Object Description Language (ODL) files.

- The egftp shareware software will be used for the ftp functions.

- The HDF shareware software will be used for reading and writing L0R product files.

7.2.3 Open Issues

This subsystem presents important issues that remain unresolved at this point in the design phase. These issues impact the software design and will not be resolved during the detailed design. The open issues are TBS.

7.3 Subsystem Design

This subsection provides a detailed description of the DMS software task model selected to implement the DMS design. The DMS designed software is a single SWCI that satisfies all the data management requirements imposed on the IAS.

The transforms presented in the DMS essential model are grouped into seven independent tasks that execute concurrently. Figure 7-2 shows the DMS task model. DMS consists of the following tasks: Data Manager (DDM), Ingest L0R Files (DID), Ingest L0R Files From Tape (DIT), Format Transmit (DFT), Ingest MOC Files (DIM), Generate Calibration Parameter File (DGC), and Resource Manager (DRM). The design of each DMS software task consists of a single SC..

Data Management Subsystem

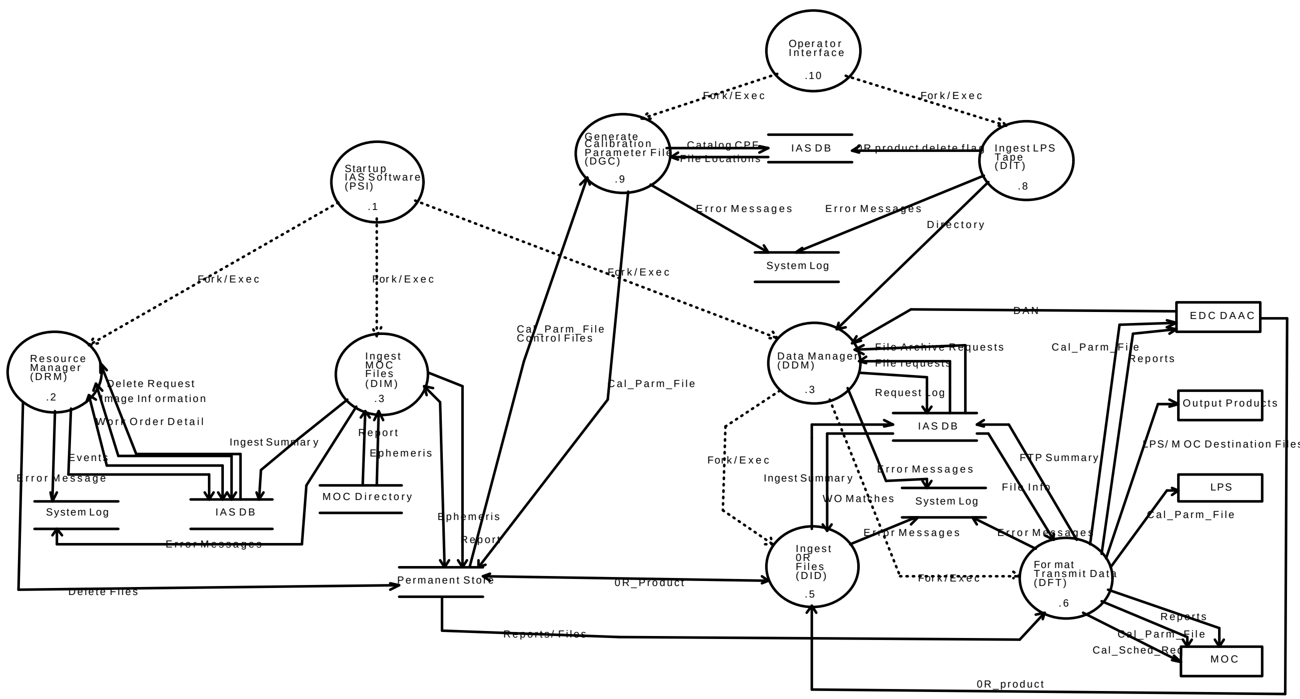

Figure 7-2. DMS Task Model

The DDM task activates and monitors tasks to retrieve L0R products from either the DAAC or tape and transmit reports and files to other facilities. When DDM receives a DAN from either the DAAC or DIT task, DDM initiates a DID task to ingest the L0R file. The DID task ftp gets the L0R product from the DAAC and then preprocesses the L0R product. When a file transmission request is made, DDM initiates the DFT task to transmit the file to the target facility. The DFT task ftp-put the requested files to the target facility.

The DIM task monitors the MOC directory for new files. When the task detects a new file, it then ingests the new MOC file by moving it to a permanent location. For the ephemeris file, the DIM task will convert it to internal format after moving it to its permanent file locationThe DRM task monitors the disk volumes, compares the L0R products and WOs for database inconsistencies (i.e., an analyst uses UNIX rm -r command to delete the WO directory and the database needs to be updated). DRM also deletes the L0R product directory or WO directories when DRM receives a delete request.

The DIT utility allows the user to either change the L0R product’s delete flag to “not delete” or send an ingest from tape command to the DDM task to start ingesting a L0R product on disk. This utility is run from the command line.

The key objective used in the task-level design was to identify the primary services required of DMS software and to evaluated their implementation as sequential or concurrent activities relative to each other. The six tasks (DDM, DID, DIT, DFT, DIM, DRM) were selected as candidates for implementation as concurrent processes.

Also part of the DMS task model is the global data stores that contain information used by tasks for performing the required functions and communicating with other tasks. The DMS software design uses a local COTS database to store and manipulate information about received image files, products, and reports generated from the received input files. The database contains setup and configuration information needed by the DMS to perform its required functions.

The following subsections present the description of each task. This description consists of an initialization, normal operation, error handling, and design of the task.

7.3.1 Data Manager (DDM) Task

This subsection describes the operation and design of the DDM task software.

7.3.1.1 Initialization and Configuration

The DDM task initialization consists connecting to the database, retrieving IAS configuration information, creating a signal handler for the task, and creating a rendezvous socket for the DAAC. The database file transfer requests will be reset to "Pending," so that any files that were interrupted during abort/shutdown will be transferred by the DFT task. Any errors encountered during task initialization result in the DDM task's exiting prematurely.

7.3.1.2 Normal Operation

The DDM task activates and monitors possibly several instances of ingest element (DID child task) and distribution element (DFT child task). When a DAAC DAN request or start ingest command is received, the DID task will be started to retrieve (if it is a DAN) and process the L0R product. When a file or report needs to be transmitted, the DFT task will be started to transmit the file or report to the requester.

During normal operation, the DDM task loops until an IAS shutdown directive is received. The loop processes a child task termination, establishes a physical socket connection with the DAAC, gets L0R products, and ftps data to facilities.
When a child process terminates, the DDM task sends a Process Completion Notification. The DDM task will start a DID task for each DAN received from the DAAC

The DDM task starts a DID task for each start ingest command received from the DIT task. The DDM task polls the database for transfer requests by the analyst. A DFT task will be started to process the transfer request(s).

7.3.1.3 Error Handling

The following list shows the types of errors that DDM may encounter and how DDM will process these errors:

Error	Action Taken
Can’t connect to IAS DB	Report error to IAS s/w log and exit process
Can’t start child process	Report error and continue
Can’t read/update database	Report error and continue
Can't read DAAC socket	Report error and close socket
DAAC socket closes	Close its socket and wait for another connection from the DAAC

7.3.1.4 Design

This subsection presents the design of the DDM task. Figure 7-3 presents the structure chart of the DDM task. The following tables identify the high level inputs and outputs of the task:

Control

Data Item	Source	Description
DAN	DAAC	Information about the contents of an available L0R product sent to DMS
Directory	DIT	0R directory to ingest
File requests	DMS	Transmit reports and/or files

REVIEW

Data Manager

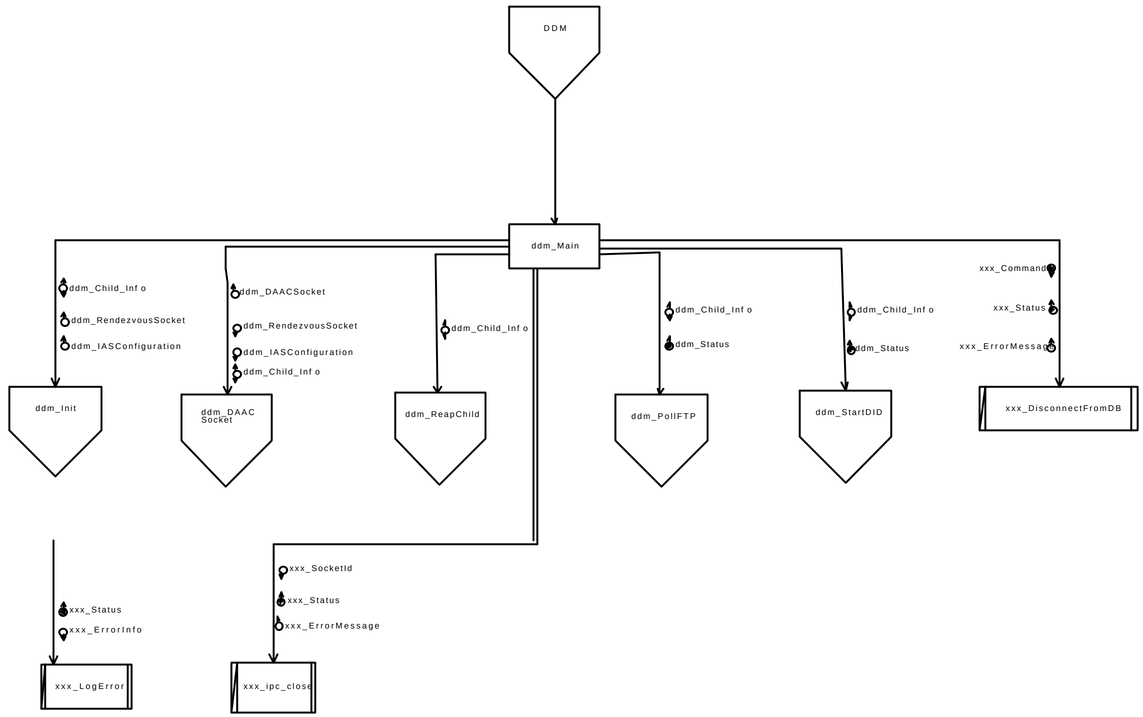

Figure 7-3. DDM Task DesignOutput

Output

Data Item	Source	Description
System Log	IAS disk	Log of any IAS s/w errors
Event Log	IAS DB	DDM writes an event when errors occur

Algorithm

The following PDL for the unit ddm_Main describes the high level programming logic of the task:

Initialize ddm_Terminate to FALSE
Call ddm_Init() to initialize the DDM task

DOWHILE not terminated and ddm_Child_Info has children
    Call ddm_DAACSocket() to check the DAAC socket for connections or messages
    Call ddm_ReapChild() to check for any terminated child processes
    Call ddm_PollFTP() to poll user interface for FTP commands
    Call ddm_StartDID() to start the DID task
ENDDO

Call xxx_ipc_close() to close the DAAC socket
Call xxx_DisconnectFromDB to disconnect from database
IF database error THEN
    Call xxx_LogError() to log error message
ENDIF

EXIT EXIT_SUCCESS

The following table lists all DDM task units and their purpose:

Unit Name	Purpose
ddm_Accept	Accept the socket connection
ddm_DAACSocket	Controls the socket logic
ddm_Handler	Signal hander
ddm_Init	Initialize the DDM task
ddm_Main	Controls the DDM task
ddm_PollFTP	Check for FTP commands and starts DFT
ddm_ReapChild	Reaps the status's for dead processes
ddm_SIPC	Reads messages off the DAAC socket
ddm_StartDID	Starts up DID tasks
ddm_WriteDAN	Writes out DAN file to the L0R product directory

7.3.2 Ingest L0R Files (DID) Task

This subsection describes the operation and design of the DID task software.

7.3.2.1 Initialization and Configuration

The DID task initialization consists connecting to the database, creating a signal handler for the task, and retrieving IAS configuration information from the database. Any errors encountered during task initialization result in the DID task's exiting prematurely.

7.3.2.2 Normal Operation

The DID task is be started by DDM task each time a new DAN is received from the DAAC or a start ingesting from tape command from DIT task. For the DAN message, the DID task will retrieve all L0R files listed in the DAN. It will then verify the files and quality check them. For the start ingesting from tape command, the DID task will skip the ftp logic and start the verifying the files immediately. The DID task will correct the PCD and MSCD files. The L0R product will then be checked against the WO list to see if the L0R product is associated with at least one WO. An ingest status will be written to the database when the DID task finishes.

7.3.2.3 Error Handling

The following list shows the types of errors that DID may encounter and how DID will process these errors:

Error	Action Taken
A HDF file error	Report error and terminate task
Can’t connect to IAS DB	Report error to IAS s/w log and terminate task
Can’t read/update database	Report error and terminate task
FTP problems	Report error and terminate task
UNIX errors creating directories	Report error and terminate task

7.3.2.4 Design

This subsection presents the design of the DID task. Figure 7-4 presents the structure chart of the DID task. The following tables identify the high level inputs and outputs of the task:.

Input

Data Item	Source	Description
0R Product	DAAC	Level 0R Image files
Directory	DIT	Ingest from tape command

Ingest 0R Files

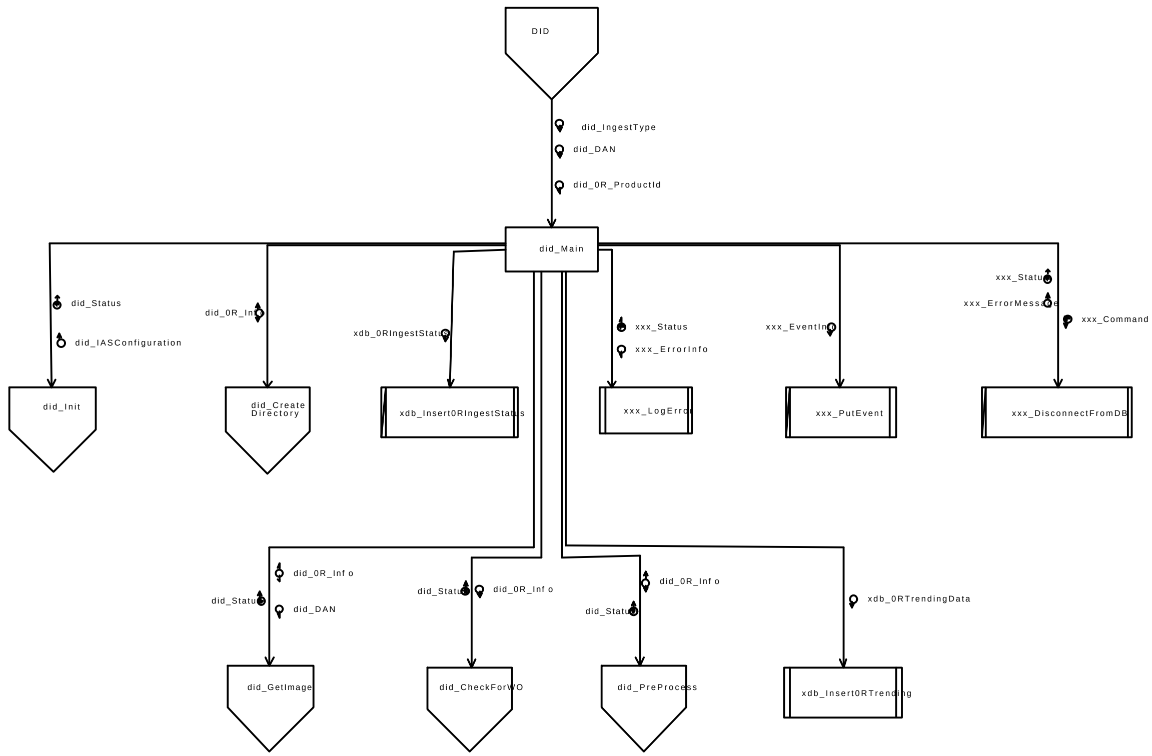

Figure 7-4. DID Task DesignControl

Control

Data Item	Source	Description
DAN	DAAC	Information about the contents of an available L0R product sent to DMS
Ingest type	DDM	Indicates what type of ingest this is (DAN or tape)

Output

Data Item	Source	Description
0R product	PCS	L0R image files
System Log	IAS disk	Log of any IAS s/w errors
Event Log	IAS DB	DID writes an event when errors occur

Algorithm

The following PDL for the unit did_Main describes the high level programming logic of the task:

```
Call did_Init() to initialize the DID task
If error initializing THEN
        ABORT to FATAL_ERROR
ENDIF

IF IngestType indicates DAN THEN
        Call did_CreateDirectory() to create the L0R product directory
        IF error creating directory THEN
                ABORT to FATAL_ERROR
        ENDIF

        Call did_GetImage() to get the L0R product files
        IF error getting L0R product THEN
                ABORT to FATAL_ERROR
        ENDIF
ELSE
        Initialize L0R path information
        Change directory to new L0R directory
        IF I/O error changing directory THEN
                Call xxx_LogError() to write the error message
                Call xxx_PutEvent() to write the event to the database
                ABORT to FATAL_ERROR
        ENDIF
        Call did_IngestStatus() to write ingest status
ENDIF
```

```
Call did_PreProcess() to preprocess the L0R product
If error preprocessing  L0R product THEN
        ABORT to FATAL_ERROR
ENDIF

FATAL_ERROR:
        Call xdb_Insert0RTrending() to insert L0R trending data
        IF database error THEN
                Call xxx_LogError() to write the error message
                Call xxx_PutEvent() to write the event to the database
        ENDIF

        Call xdb_Insert0RIngestStatus() to insert L0R product ingest status
        IF database error THEN
                Call xxx_LogError() to write the error message
                Call xxx_PutEvent() to write the event to the database
        ENDIF

        IF ingest status is not failure THEN
                Call xxx_PutEvent() to write a successful ingest notification to the database
                Call did_CheckForWO() to see if the L0R product is used in any WO
        ELSE
                Call xxx_PutEvent() to write failed ingest notification to the database
        ENDIF

        Call xxx_DisconnectFromDB() to disconnect from database
        IF database error THEN
                Call xxx_LogError() to write the error message
        ENDIF

        EXIT EXIT_SUCCESS
```

The following table lists all DID task units and their purpose:

Unit Name	Purpose
did_CalculateCaptureDirection	Calculates the capture direction
did_CalculateTempFit	Calculate the TBD temp fits
did_CheckForWO	Check to see if L0R product is associate with a WO
did_CreateDDR	Creates the DDR file
did_CreateDirectory	Creates the L0R directory
did_CreateReport	Create the L0R report file
did_FixMSCDTime	Apply the time corrections to the MSCD times
did_FixPCDTime	Apply the time corrections to the PCD times
did_GetCPFValidationInfo	Get the CPF fields needed for ingest

Unit Name	Purpose
did_GetImage	FTPs over the L0R files listed in the DAN
did_IngestMSCD	Controls the ingesting of MSCD
did_IngestPCD	Controls the ingesting of PCD
did_IngestStatus	Writes messages to the local L0R product status log
did_Init	Initialize the DID task
did_Main	Controls the DID task
did_PreProcess	Controls the ingest process
did_UpdateMSCD	Updates MSCD format 1 file with all corrections
did_UpdatePCD	Updates PCD format 1 file with all corrections
did_ValidateADS	Validates ADS
did_ValidateAttitude	Validates attitude
did_ValidateCalData	Validates band calibration files
did_ValidateCPF	Validates IAS CPF
did_ValidateEphemeris	Validates ephemeris
did_ValidateFHS_SHSError	Validates FHS/SHS
did_ValidateGeo	Validates geolocation table
did_ValidateGyro	Validates gyro
did_ValdiateGyroDrift	Validates gyro drift
did_ValidateInstrumentOnTime	Validates instrument on time
did_ValidateLineLength	Validates line length
did_ValidateMSCD	Controls the validation for MSCD file
did_ValidatePCD	Controls the validation for PCD file
did_ValidateScanDirection	Validates the scan direction
did_ValidateScanStartTime	Validate the scan start time
did_ValidateScene	Controls the validation of band/cal band data
did_ValidateSceneData	Validates the band scene data
did_ValidateSLO	Validates the scan line offset table
did_ValidateTemp	Validates the temperatures
did_ValidateTimeCorrection	Validates the time correction

7.3.3 Format Transmit Data (DFT) Task

This subsection describes the design of the DFT task software.

7.3.3.1 Initialization and Configuration

The DFT task initialization consists connecting to the database, creating a signal handler for the task, and retrieving IAS configuration information from the database. Any errors encountered during task initialization result in the DFT task's exiting prematurely.

7.3.3.2 Normal Operation

When a file(s) needs transmission, the DFT task started by DDM task transmits the file(s) to the designated facility. The DFT task first updates the status to "Starting to transmit" in the database and retrieves all the file information necessary to transmit the file(s) over to the target facility. The DFT task then ftps the file(s) over to the target facility using the egftp library units. As each file is transferred over, the database is be updated to indicated that the file was transferred.

7.3.3.3 Error Handling

The following list shows the types of errors that DFT may encounter and how DFT will process these errors

Error	Action Taken
Can’t connect to IAS DB	Report error to IAS s/w log and terminate task
Can’t read/update database	Report error and terminate task
File can’t be found	Report error and skip file
FTP problems	Skip the file and try again later for a configurable number of times
UNIX errors creating directories	Report error and terminate task

7.3.3.4 Design

This subsection presents the design of the DFT task. Figure 7-5 presents the structure chart of the DFT task. The following tables identifies the high level inputs and outputs of the task:

Control

Data Item	Source	Description
File requests	DMS	File to transmit

Output

Data Item	Source	Description
Cal_Parm_File	DAAC/MOC/LPS	Analyst requested CPF
Cal_Sched_req	MOC	Analyst requested calibration schedule request
Event Log	IAS DB	DFT writes an event when errors occur
Reports	DAAC/MOC/MMO	Analyst requested reports
System Log	IAS disk	Log of any IAS s/w errors

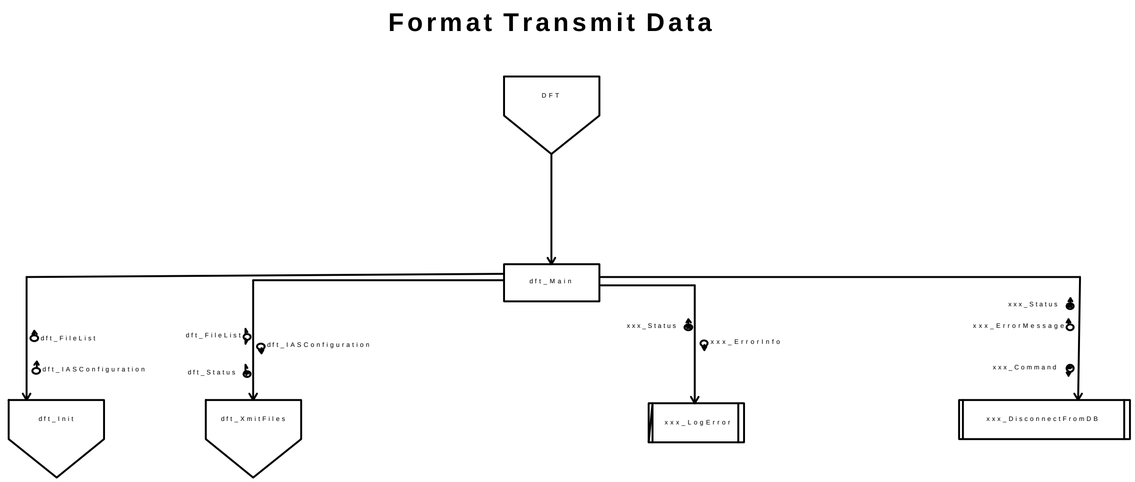

Figure 7-5. DFT Task Design

Algorithm

The following PDL for the unit dft_Main describes the high level programming logic of the task:
Call dft_Init() to initialize the DFT task

```
DOUNTIL terminated or not more files to transmit
	DOWHILE not terminated and more remote hosts or database error
			Call dft_XmitFiles() to transfer all files for that remote hosts
	ENDDO
	IF no database errors THEN
		IF some files failed to transfer over THEN
			Pause for a while
		ENDIF
	ENDIF
ENDDO

Call xxx_DisconnectFormDB() to disconnect from database
If database error THEN
	Call xxx_LogError() to log error message
ENDIF

IF database error THEN
	EXIT EXIT_FAILURE
ELSE
	EXIT EXIT_SUCCESS
ENDIF
```

The following table lists all DFT task units and their purpose:

Unit Name	Purpose
dft_GetXmitList	Gets all files waits for transmission
dft_Init	Initializes the DFT task
dft_Main	Controls the DFT task
dft_XmitFiles	FTPs over the files to the target host

7.3.4 Ingest MOC Files (DIM)

This subsection describes the operation and design of the DIM task software.

7.3.4.1 Initialization and Configuration

The DIM task initialization consists of connecting to the database, creating a signal handler for the task, and retrieving IAS configuration information from the database. Any errors encountered during task initialization result in the DIM task's exiting prematurely.

7.3.4.2 Normal Operation

During normal operation, the DIM task loops until an IAS receives a shutdown directive. Within the loop, DIM checks the MOC input ftp directory for files. When a MOC file finishes arriving, the DIM task moves the files to a permanent location on the disk. DIM converts the ephemeris files to the UNIX file format. Any definitive ephemeris files will have their first 7 minutes of data appended to the previous week’s ephemeris file (this enables interpolation for points at the week boundary). DIM updates the database with the new file information.

7.3.4.3 Error Handling

The following list shows the types of errors that DIM may encounter and how DIM will process these errors:

Error	Action Taken
Can’t connect to IAS DB	Report error to IAS s/w log and terminate task
Can’t read/update database	Report error and continue
UNIX errors reading, creating, moving directories/files	Report error and continue

7.3.4.4 Design

This subsection presents the design of the DIM task. Figure 7-6 presents the structure chart of the DIM task..The following tables identify the high level inputs and outputs of the task

Input

Data Item	Source	Description
DIM setup	IAS DB	task setup info including polling interval, polling directory, etc.
FDF ephemeris	MOC	FDF definitive or concentrated ephemeris
MOC Reports	Reports	Reports generated by MOC. For example the MOC event report is used to identify when FASC/PASC scenes occur.

Output

Data Item	Source	Description
Ephemeris catalog	IAS DB	Summary of an ingested ephemeris file
Event Log	IAS DB	DIM writes an event when errors occur or MOC reports are received
System Log	IAS disk	Log of any IAS s/w errors

Ingest MOC Files

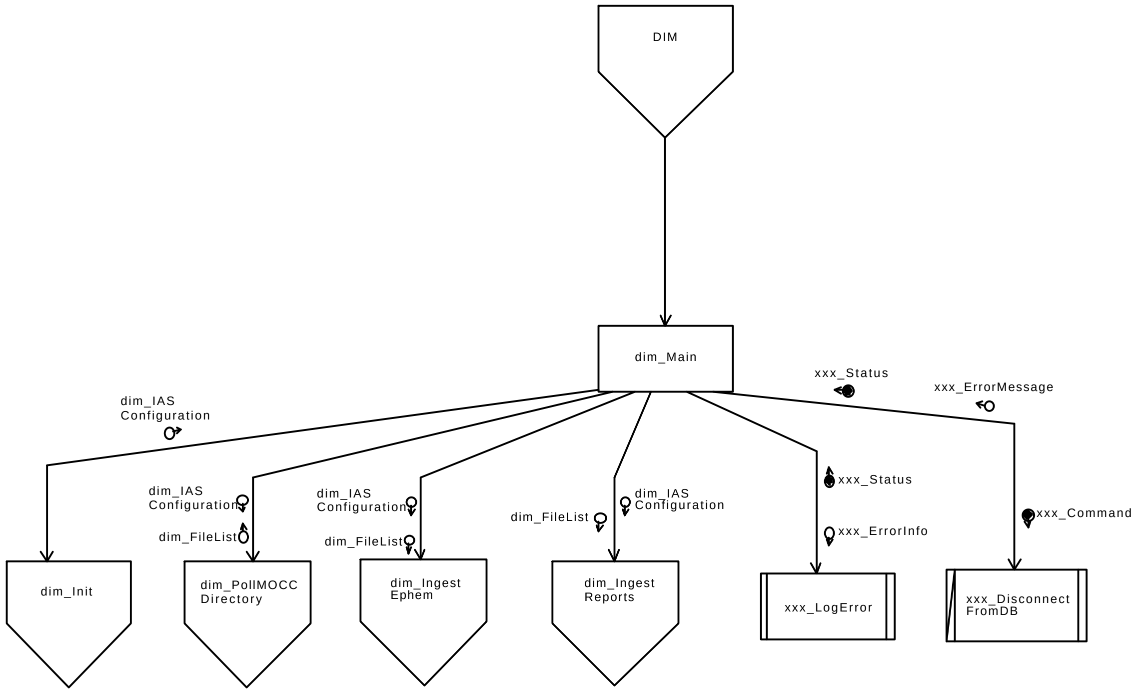

Figure 7-6. Task DIM Design

Algorithm

The following PDL for the unit dim_Main describes the high level programming logic of the task:

```
Call dim_Init() to initialize task and retrieve setup information

DOUNTIL shutdown directive received
        Call dim_PollMOCCDirectory() to identify all new files in MOC input directory
        DOFOR each file found
                IF file is ephemeris file THEN
                        Call dim_IngestEphem() to ingest MOC ephemeris file in database
                ELSE
                        Call dim_IngestReports() to store report in database
                ENDIF
        ENDDO
        Free dim_FileList
        Sleep for a while

ENDDO

Call xxx_DisconnectFromDB() to disconnect form the database
IF disconnect fails THEN
        Call xxx_LogError() to write error message to local log
ENDIF

EXIT EXIT_SUCCESS
```

The following table lists all DIM task units and their purpose:

Unit Name	Purpose
dim_IngestEphem	Ingest an ephemeris file. A definitive ephemeris file must be merged with previous week's file
dim_IngestReports	Ingest a MOC and write an event to IAS DB to notify operator
dim_Init	Initialize the DIM task
dim_Main	Controls the DIM task
dim_MergeDefEphem	Merge current definitive ephemeris file with the previous week's file
dim_PollMOCCDirectory	Check if MOC has ftp'd any files to the MOC input directory

7.3.5 Resource Management (DRM)

This subsection describes the operation and design of the DRM task software.

7.3.5.1 Initialization and Configuration

The DRM task initialization consists connecting to the database, creating a signal handler for the task, and retrieves IAS configuration information from the database. Any errors encountered during task initialization result in the DRM task's exiting prematurely.

7.3.5.2 Normal Operation

During normal operation, the DRM task loops until an IAS receives a shutdown directive. Within the loop, the DRM task monitors the disk usage, deletes images and WOs on request, and compares the images and WO directories against the database for mismatches.

7.3.5.3 Error Handling

The following list shows the types of errors that DRM may encounter and how DRM will process these errors:

Error	Action Taken
Can’t connect to IAS DB	Report error to IAS s/w log and terminate task
Can’t read/update database	Report error and continue
UNIX errors reading, deleting, or tarring directories	Report error and continue

7.3.5.4 Design

This subsection presents the design of the DRM task. Figure 7-7 presents the structure chart of the DRM task. The following tables identify the high level inputs and outputs of the task:

Input

Data Item	Source	Description
Control Information	Database	Identify expired WOs
Image Information	Database	Identify expired images

Control

Data Item	Source	Description
Manual Delete request	UI	Allow UI analyst to delete images or products

Output

Data Item	Source	Description
Event Log	IAS DB	DRM writes an event when errors occur
Image information	image	Delete images
System Log	IAS disk	Log of any IAS s/w errors

REVIEW

Work order detail	Work order	Delete WOs

Resource Manager

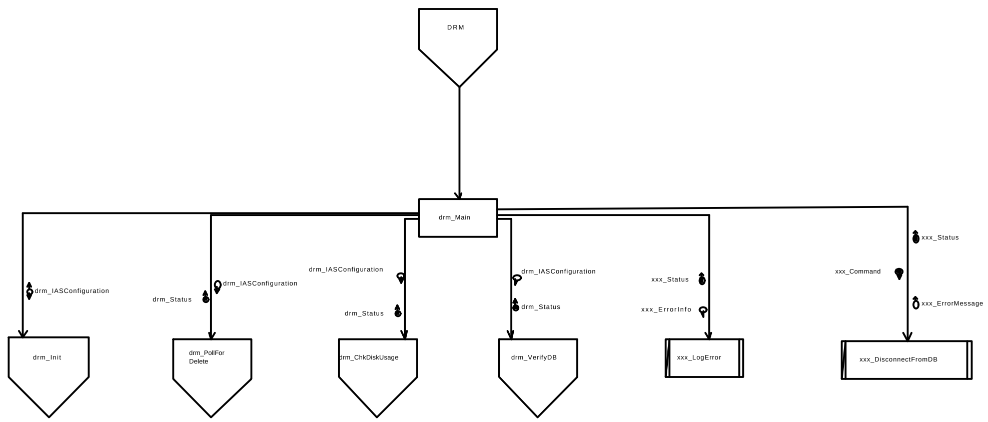

Figure 7-7. DRM Task Design.

Algorithm

The following PDL for the unit drm_Main describes the high level programming logic of the task:

```
Call drm_Init() to initialize the DRM task
DOWHILE not terminated
        IF Time to poll database THEN
                Call drm_PollForDelete() to poll database for delete commands
        ENDIF
        IF time to check disk usage THEN
                Call drm_ChkDiskUsage() to check the disk usage
        ENDIF
        IF time to verify disk THEN
                Call drm_VerifyDB() to verify the disk against the database
        ENDIF
ENDDO

Call xxx_DisconnectFromDB() to disconnect from database
IF database error THEN
        Call xxx_LogError() to log error message
ENDIF
```

EXIT_SUCCESSThe following table lists all DRM task units and their purpose:

Unit Name	Purpose
drm_ChkDiskUsage	Check the disk usage
drm_Init	Initialize the DRM task
drm_Main	Controls the DRM task
drm_PollForDelete	Check the database for files to delete
drm_VerifyDB	Verify the database against the hard disk

7.3.6 Ingest From Tape (DIT)

This subsection describes the operation and design of the DIT task software.

7.3.5.1 Initialization and Configuration

The DIT task initialization consists of parsing the user command, connecting to the database, creating a signal handler for the task, and retrieves IAS configuration information from the database. Any Errors encountered during task initialization result in the DIT task's exiting prematurely.

7.3.5.2 Normal Operation

The DIT task is a one shot utility started on the UNIX command line. It allows the user to either reset a L0R product's delete flag to "not deleted" or send a start ingesting from tape command to the DDM task. The user will first manually make the L0R directory on the product partition and restore the L0R product files from tape. The user will then start up the DIT task using the option flags. The DIT task will parse the option flags and either update the product's delete flag to "not deleted" in the database or open a socket connection to the DDM task and write the start ingesting from tape command. The DIT task writes an event to the database indicating the completion of the DIT operation.

7.3.5.3 Error Handling

The following list shows the types of errors that DIT may encounter and how DIT will process these errors:

Error	Action Taken
Can't connect to IAS DB	Report error to IAS s/w log and terminate task
Can't read/update database	Report error and terminate task
DAAC key is not in the database for "un-delete L0R"	Report error and terminate task
File can't be found	Report error and terminate task

7.3.5.4 Design

This subsection presents the design of the DIT task. Figure 7-8 presents the structure chart of the DIT task. The following tables identify the high level inputs and outputs of the task:

Input Control

Data Item	Source	Description
Directory	User Interface	DAAC directory name to ingest or update

Output

Data Item	Source	Description
Directory	DDM	0R directory to ingest
0R product delete flag	database	Update delete flag to "not deleted"
Reports	DAAC/MOC/MMO	Analyst requested reports
System Log	IAS disk	Log of any IAS s/w errors
Event Log	IAS DB	DIT writes an event when errors occur

Ingest from LPS Tape

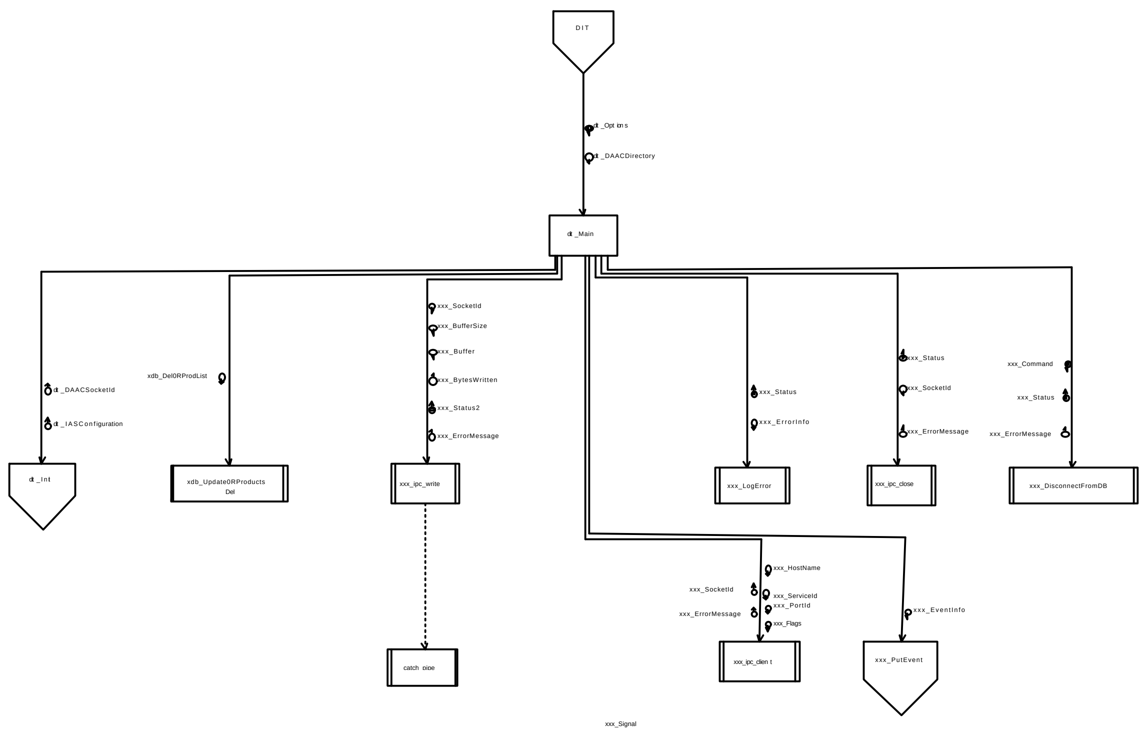

Figure 7-8. DIT Task Design

Algorithm

The following PDL for the unit dit_Main describes the high level programming logic of the task:

```
Initializes variables

DOWHILE more arguments
    Call getopt() to get the next option
    DOCASE option
    CASE update:
        Set update flag
    CASE DAAC directory name:
        Extract DAAC directory name
    ELSE
        Write the usage error message to standard out
        EXIT
    ENDDO
ENDDO
IF the p_DAACDirectory argument is missing THEN
    Write the usage error message to standard out
ELSEIF the p_DAACDirectory does not exist THEN
    Write the directory does not exist message to standard out
ELSE
    Call did_Init() to initialize the DIT task
    IF update flag is set THEN
        Call xdb_Update0RProductDel() to update the L0R product
        IF database error THEN
            Call xxx_LogError() to log error message
            Write the error message to standard out
        ENDIF
    ELSE
        Call xxx_ipc_client() to create DAAC client socket
        If write error THEN
            Call xxx_LogError() to log error message
            Write the error message to standard out
        ELSE
```

```
                Call xxx_ipc_write() to write the start LPS tape ingest command for
                  p_DAACDirectory
                If write error THEN
                        Call xxx_LogError() to log error message
                        Write the error message to standard out
                ENDIF
                Call xxx_ipc_close() to close the DAAC socket
        ENDIF
        IF no errors THEN
                Call xxx_PutEvent() to write operation success event to the database
                Write the DAAC command set OK message to standard out
        ELSE
                Write the command failed message to standard out
        ENDIF
    ENDIF
ENDIF

Call xxx_DisconnectFromDB() to disconnect from the database
IF database error THEN
    Call xxx_LogError() to log error message
ENDIF

EXIT EXIT_SUCCESS
```

The following table lists all DIT task units and their purpose:

Unit Name	Purpose
dit_Init	Initialize the DIT task
dit_Main	Execute the user command

7.3.7 Generate Calibration Parameter File (DGC)

This subsection describes the design of the DGC task software.

7.3.7.1 Initialization and Configuration

The DGC task initialization consists of parsing the user command, connecting to the database, creating a signal handler for the task, and retrieves IAS configuration information from the database. Any Errors encountered during task initialization result in the DGC task's exiting prematurely.

7.3.7.2 Normal Operation

The DGC task is a one shot a utility started either on the UNIX command line or via the user interface. When the geometry and/or radiometry analysts finish changing their fields, the

DGC task is started up to merge those changes into the base CPF. The new CPF is then written to the disk. A log of what changes were made is generated to disk. DGC inserts the new CPF information into the database. The DGC task exits.

7.3.7.3 Error Handling

The following list shows the types of errors that DGC may encounter and how DGC will process these errors:

Error	Action Taken
Can’t connect to IAS DB	Report error to IAS s/w log and terminate task
Can’t read/update database	Report error and terminate task
ODL errors	Report error and terminate task
UNIX errors	Report error and terminate task

7.3.7.4 Design

This subsection presents the design of the DGC task. Figure 7-9 presents the structure chart of the DGC task. The following table identifies the high level inputs and outputs of the task:

Input

Data Item	Source	Description
Cal_Parm_File Control Files	Disk	ODL file that defines what fields in the Control Files CPF can be updated by radiometry and geometry, Geometry CPF updates, Radiometry CPF updates, and default CPF
File_Locations	Database	Location of Cal_Parm_File Control Files

Output

Data Item	Source	Description
Catalog CPF	Database	Calibration generation information
Cal_Parm_File	Disk	New CPF
System Log	IAS disk	Log of any IAS s/w errors
Event Log	IAS DB	DGC writes an event when errors occur

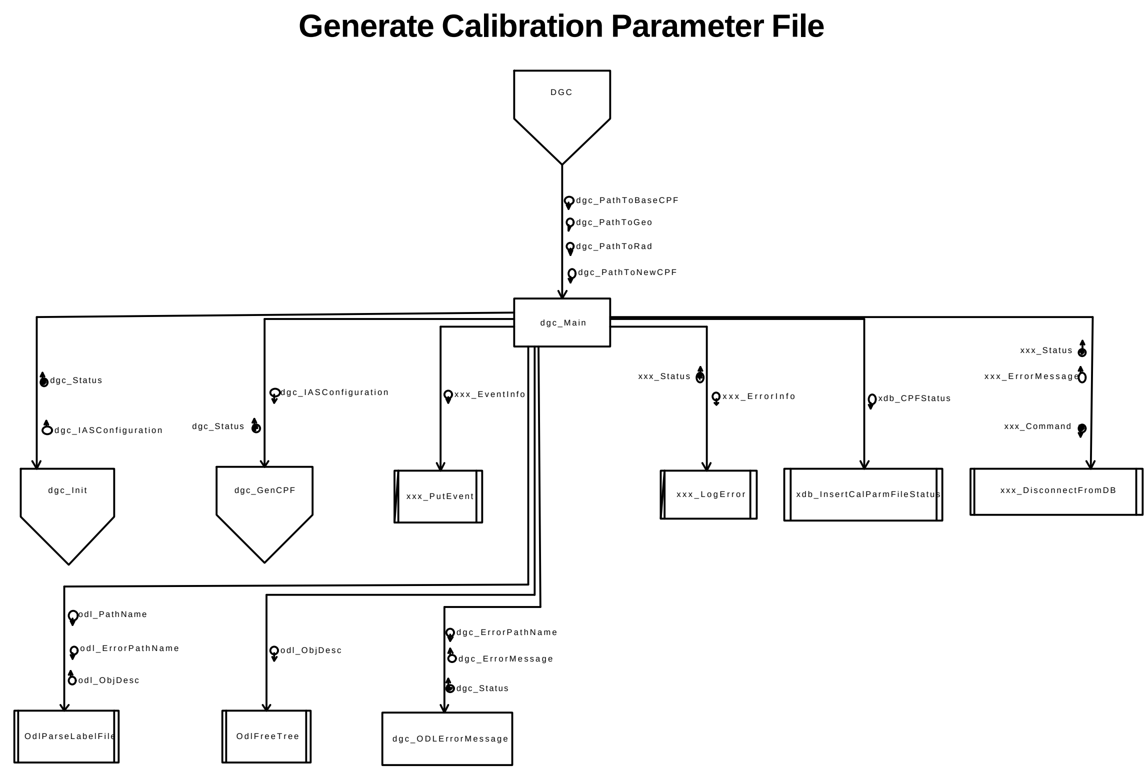

Figure 7-9. DGC Task Design

REVIEW

Algorithm

The following PDL for the unit dgc_Main describes the high level programming logic of the task:

```
Set exit status to EXIT_FAILURE

Call dgc_Init() to initialize the DGC task
If error initializing THEN
        ABORT to FATAL_ERROR
ENDIF

DOWHILE more arguments
        Call getopt() to get the next option
        DOCASE option
        CASE base CPF path:
                Extract the base CPF path
                Call OdlParseLabelFile() to parse in the base CPF file
                IF parse failed THEN
                        dgc_ODLErrorMessage() to get ODL error
                        Call xxx_LogError() to log error message
                        Call xxx_PutEvent() to write event to database
                ENDIF
        CASE geometry path:
                Extract the geometry path
                Call OdlParseLabelFile() to parse in the geometry CPF file
                IF parse failed THEN
                        dgc_ODLErrorMessage() to get ODL error
                        Call xxx_LogError() to log error message
                        Call xxx_PutEvent() to write event to database
                ENDIF

        CASE radiometry path:
                Extract the radiometry path
                Call OdlParseLabelFile() to parse in the radiometry CPF file
                IF parse failed THEN
                        dgc_ODLErrorMessage() to get ODL error
                        Call xxx_LogError() to log error message
                        Call xxx_PutEvent() to write event to database
                ENDIF
        CASE new CPF path:
                Extract the new CPF path
        ELSE
                Call xxx_LogError() to log error message
                Call xxx_PutEvent() to write event to database
```

```
        ABORT to FATAL_ERROR
    ENDDO
ENDDO

IF don't have all arguments THEN
    Call xxx_LogError() to log error message
    Call xxx_PutEvent() to write event to database
ENDIF

IF don't have all arguments or error in arguments THEN
    Call odlFreeTree() to free files
    ABORT to FATAL_ERROR
ENDIF

Call dgc_GenCPF() to merge geometry/radiometry file(s) into the CPF
IF CPF file created successfully THEN
    Call xdb_InsertCalParmFileStatus() to insert the CPF creation status
    IF database error THEN
        Call xxx_LogError() to log error message
        Call xxx_PutEvent() to write event to database
    ELSE
        Set exit status to EXIT_SUCCESS
    ENDIF
ENDIF

FATAL_ERROR:
    Call xxx_DisconnectFromDB() to disconnect from database
    IF database error THEN
        Call xxx_LogError() to log error message
    ENDIF

    EXIT exit status
```

The following table lists all DGC task units and their purpose:

Unit Name	Purpose
dgc_GenCPF	Merges in the changes and writes out new CPF
dgc_Init	Initialize the DGC task
dgc_LogField	Log what was changed
dgc_Main	Execute the user command
dgc_ODLErrorMessage	Gets the ODL error message from the error file

Section 7. Data Management Subsystem

7.1 Introduction

The Data Management Subsystem (DMS) provides file ingest, resource monitoring, file deletion, and file transfer.

7.2 Design Overview

This section provides an overview of the DMS software design that includes relationship between the DMS and other IAS subsystems and a software task model showing the interdependency among DMS software components. In addition, this section identifies the assumptions, constraints and considerations that were used during the design process.

7.2.1 Subsystem Software Overview

Figure 7-1 contains the context diagram of DMS. As shown, DMS interfaces with the DAAC, MOC, LPS and IAS database. The DMS receives the L0R product from the DAAC either electronically or by tar tape; the DMS sends the CPF and reports to the DAAC. The DMS receives ephemeris data and reports from the MOC; the DMS sends data acquisition request, ephemeris request, CPF, and reports to the MOC. The DMS sends CPF to the LPS. The DMS communicates with other subsystems via the IAS database.

Initially, either the DAAC sends a DAN to the IAS when a L0R product is available or the user will start up a utility that will send an ingest start command to the DMS. When DMS receives a DAN, the DMS processes the DAN and retrieves the files listed in the DAN. When a utility is used, the user has already created the L0R directory on the IAS product partition and saved the L0R image there. The utility simply sends a start ingest command to the DMS that causes the DMS to skip the retrieval logic. With the L0R image files now on disk, the DMS performs verification and quality checking on the image product. In addition, the DMS corrects the PCD and MSCD associated with the image product. Once the DMS has preprocessed the image product, it will check to see if any WOs are associate to it.

The MOC sends files to a designated directory in the IAS. The DMS scans this directory periodically for newly arrived files. When DMS detects a new file, it moves the file to an appropriate directory. If the file is ephemeris data, DMS converts it to a binary form for use by GPS.

The DMS polls the IAS database for data transfer request. When it finds a pending transfer request, DMS retrieves the location of the file and the destination facility. Then the DMS sends the file.

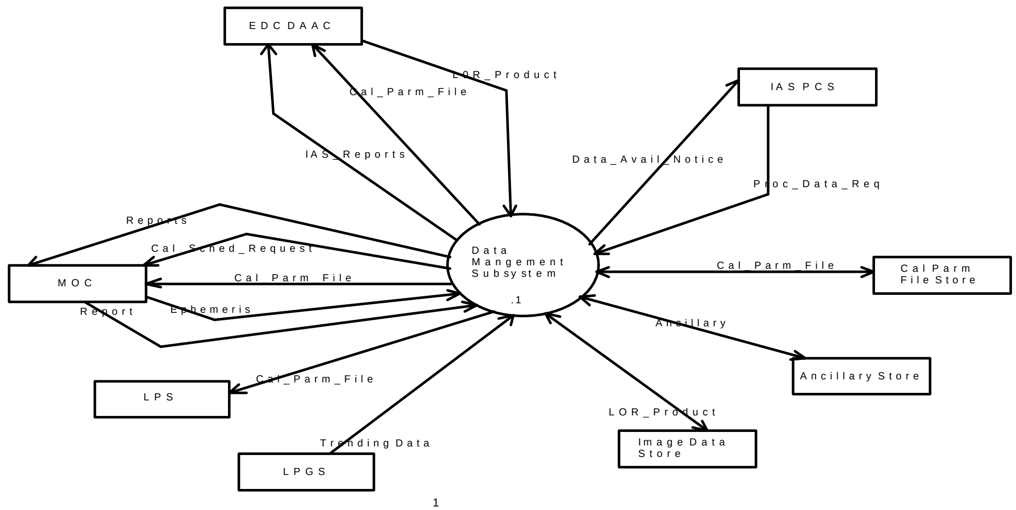

Figure 7-1. DMS Context Diagram

The DMS polls the IAS database for data delete requests. When it finds a pending delete request, DMS first retrieves the names of the WOs for deletion, it then archives the permanent WO files, and then deletes the WO's directory. DMS then retrieves the names of the L0R product identified for deletion and deletes the L0R product's directory. In addition, the DMS also monitors the disks and reports to the operator when a threshold was exceeded.

7.2.2 Design Considerations

This subsection presents the design driver relevant to the DMS software and the assumptions of the software design.

7.2.2.1 Design Assumptions

This subsection presents important assumptions at this point in the design. These assumptions impact software design and remain in effect until notified otherwise.

- When the MOC file size has not increased for a specified time period, the DMS will assume that the file transfer is complete.
- The DMS will receive a DAN message notifying DMS where to retrieve L0R products from the DAAC.
- The DMS will receive tar tapes that contain L0R product in DAAC file format.
- The DMS will not write out any intermediate messages to database while ingesting files from the DAAC or MOC.
- The DMS task will automatically copy files to target facilities.
- The L0R product file name will be unique.

7.2.2.2 Subsystem Support of Operational Scenarios

Table 7-1 maps the DMS-related operational scenarios (Section 4) to the supporting tasks.

Table 7-1. DMS-related Operational Scenarios

Operational Scenario	Support Level
Data Delete	Major
Ingest DAAC files	Major
Ingest MOC files	Major
Transfer Files	Major
Ingest L0R from tar tapes	Major
Recover L0R products	Major

7.2.2.3 Software Reuse Strategy

This subsection identifies external components that may be reused by the DMS as well as components of the DMS software that may be useful to other IAS subsystems.

- The low-level socket management modules and some database modules will be reused from the Pacor II system.
- The lablib software will be used for reading, parsing, write, etc. Object Description Language (ODL) files.
- The egftp shareware software will be used for the ftp functions.
- The HDF shareware software will be used for reading and writing L0R product files.

7.2.3 Open Issues

This subsystem presents important issues that remain unresolved at this point in the design phase. These issues impact the software design and will not be resolved during the detailed design. The open issues are TBS.

7.3 Subsystem Design

This subsection provides a detailed description of the DMS software task model selected to implement the DMS design. The DMS designed software is a single SWCI that satisfies all the data management requirements imposed on the IAS.

The transforms presented in the DMS essential model are grouped into seven independent tasks that execute concurrently. Figure 7-2 shows the DMS task model. DMS consists of the following tasks: Data Manager (DDM), Ingest L0R Files (DID), Ingest L0R Files From Tape (DIT), Format Transmit (DFT), Ingest MOC Files (DIM), Generate Calibration Parameter File (DGC), and Resource Manager (DRM). The design of each DMS software task consists of a single SC..

Data Management Subsystem

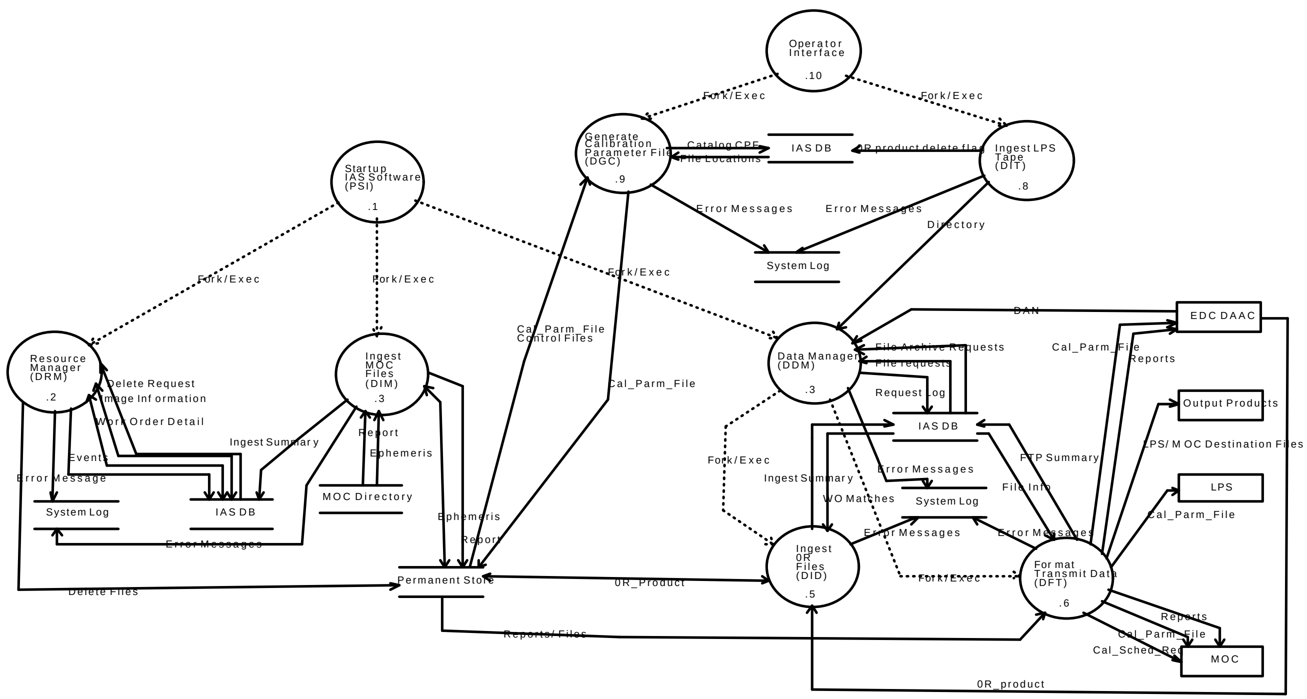

Figure 7-2. DMS Task Model

The DDM task activates and monitors tasks to retrieve L0R products from either the DAAC or tape and transmit reports and files to other facilities. When DDM receives a DAN from either the DAAC or DIT task, DDM initiates a DID task to ingest the L0R file. The DID task ftp gets the L0R product from the DAAC and then preprocesses the L0R product. When a file transmission request is made, DDM initiates the DFT task to transmit the file to the target facility. The DFT task ftp-put the requested files to the target facility.

The DIM task monitors the MOC directory for new files. When the task detects a new file, it then ingests the new MOC file by moving it to a permanent location. For the ephemeris file, the DIM task will convert it to internal format after moving it to its permanent file locationThe DRM task monitors the disk volumes, compares the L0R products and WOs for database inconsistencies (i.e., an analyst uses UNIX rm -r command to delete the WO directory and the database needs to be updated). DRM also deletes the L0R product directory or WO directories when DRM receives a delete request.

The DIT utility allows the user to either change the L0R product's delete flag to "not delete" or send an ingest from tape command to the DDM task to start ingesting a L0R product on disk. This utility is run from the command line.

The key objective used in the task-level design was to identify the primary services required of DMS software and to evaluated their implementation as sequential or concurrent activities relative to each other. The six tasks (DDM, DID, DIT, DFT, DIM, DRM) were selected as candidates for implementation as concurrent processes.

Also part of the DMS task model is the global data stores that contain information used by tasks for performing the required functions and communicating with other tasks. The DMS software design uses a local COTS database to store and manipulate information about received image files, products, and reports generated from the received input files. The database contains setup and configuration information needed by the DMS to perform its required functions.

The following subsections present the description of each task. This description consists of an initialization, normal operation, error handling, and design of the task.

7.3.1 Data Manager (DDM) Task

This subsection describes the operation and design of the DDM task software.

7.3.1.1 Initialization and Configuration

The DDM task initialization consists connecting to the database, retrieving IAS configuration information, creating a signal handler for the task, and creating a rendezvous socket for the DAAC. The database file transfer requests will be reset to "Pending," so that any files that were interrupted during abort/shutdown will be transferred by the DFT task. Any errors encountered during task initialization result in the DDM task's exiting prematurely.

7.3.1.2 Normal Operation

The DDM task activates and monitors possibly several instances of ingest element (DID child task) and distribution element (DFT child task). When a DAAC DAN request or start ingest command is received, the DID task will be started to retrieve (if it is a DAN) and process the L0R product. When a file or report needs to be transmitted, the DFT task will be started to transmit the file or report to the requester.

During normal operation, the DDM task loops until an IAS shutdown directive is received. The loop processes a child task termination, establishes a physical socket connection with the DAAC, gets L0R products, and ftps data to facilities.
When a child process terminates, the DDM task sends a Process Completion Notification.
The DDM task will start a DID task for each DAN received from the DAAC

The DDM task starts a DID task for each start ingest command received from the DIT task. The DDM task polls the database for transfer requests by the analyst. A DFT task will be started to process the transfer request(s).

7.3.1.3 Error Handling

The following list shows the types of errors that DDM may encounter and how DDM will process these errors:

Error	Action Taken
Can’t connect to IAS DB	Report error to IAS s/w log and exit process
Can’t start child process	Report error and continue
Can’t read/update database	Report error and continue
Can't read DAAC socket	Report error and close socket
DAAC socket closes	Close its socket and wait for another connection from the DAAC

7.3.1.4 Design

This subsection presents the design of the DDM task. Figure 7-3 presents the structure chart of the DDM task. The following tables identify the high level inputs and outputs of the task:

Control

Data Item	Source	Description
DAN	DAAC	Information about the contents of an available L0R product sent to DMS
Directory	DIT	0R directory to ingest
File requests	DMS	Transmit reports and/or files

Data Manager

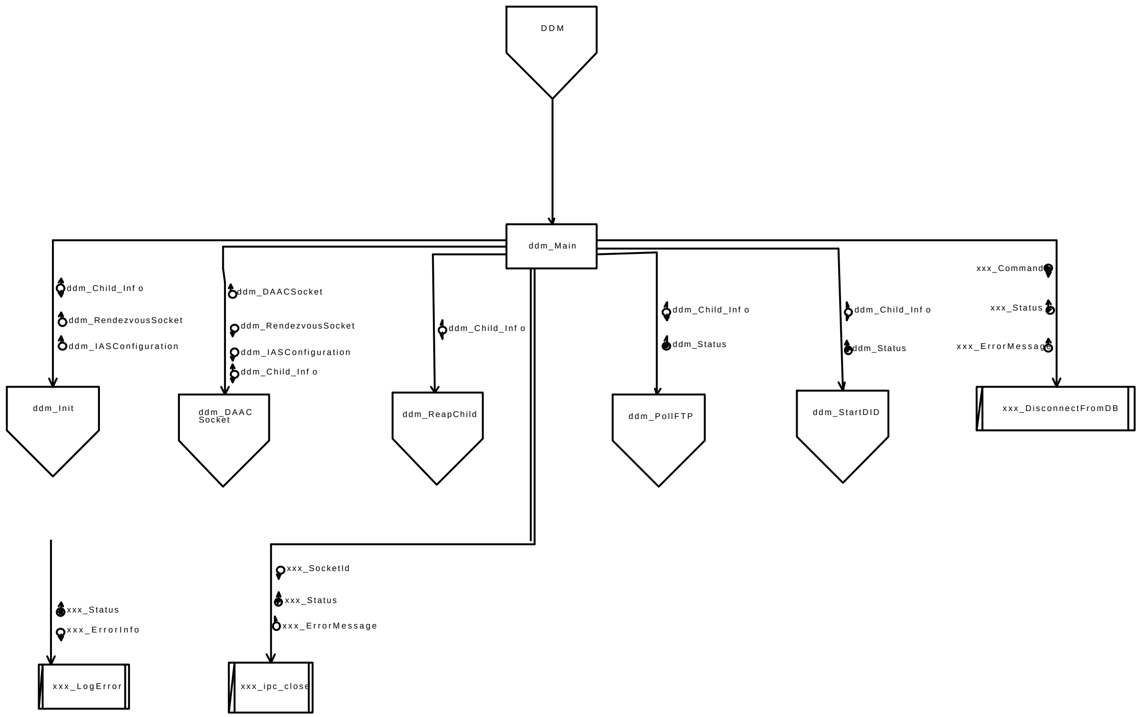

Figure 7-3. DDM Task DesignOutput

Output

Data Item	Source	Description
System Log	IAS disk	Log of any IAS s/w errors
Event Log	IAS DB	DDM writes an event when errors occur

Algorithm

The following PDL for the unit ddm_Main describes the high level programming logic of the task:

Initialize ddm_Terminate to FALSE
Call ddm_Init() to initialize the DDM task

DOWHILE not terminated and ddm_Child_Info has children
    Call ddm_DAACSocket() to check the DAAC socket for connections or messages
    Call ddm_ReapChild() to check for any terminated child processes
    Call ddm_PollFTP() to poll user interface for FTP commands
    Call ddm_StartDID() to start the DID task
ENDDO

Call xxx_ipc_close() to close the DAAC socket
Call xxx_DisconnectFromDB to disconnect from database
IF database error THEN
    Call xxx_LogError() to log error message
ENDIF

EXIT EXIT_SUCCESS

The following table lists all DDM task units and their purpose:

Unit Name	Purpose
ddm_Accept	Accept the socket connection
ddm_DAACSocket	Controls the socket logic
ddm_Handler	Signal hander
ddm_Init	Initialize the DDM task
ddm_Main	Controls the DDM task
ddm_PollFTP	Check for FTP commands and starts DFT
ddm_ReapChild	Reaps the status's for dead processes
ddm_SIPC	Reads messages off the DAAC socket
ddm_StartDID	Starts up DID tasks
ddm_WriteDAN	Writes out DAN file to the L0R product directory

7.3.2 Ingest L0R Files (DID) Task

This subsection describes the operation and design of the DID task software.

7.3.2.1 Initialization and Configuration

The DID task initialization consists connecting to the database, creating a signal handler for the task, and retrieving IAS configuration information from the database. Any errors encountered during task initialization result in the DID task's exiting prematurely.

7.3.2.2 Normal Operation

The DID task is be started by DDM task each time a new DAN is received from the DAAC or a start ingesting from tape command from DIT task. For the DAN message, the DID task will retrieve all L0R files listed in the DAN. It will then verify the files and quality check them. For the start ingesting from tape command, the DID task will skip the ftp logic and start the verifying the files immediately. The DID task will correct the PCD and MSCD files. The L0R product will then be checked against the WO list to see if the L0R product is associated with at least one WO. An ingest status will be written to the database when the DID task finishes.

7.3.2.3 Error Handling

The following list shows the types of errors that DID may encounter and how DID will process these errors:

Error	Action Taken
A HDF file error	Report error and terminate task
Can’t connect to IAS DB	Report error to IAS s/w log and terminate task
Can’t read/update database	Report error and terminate task
FTP problems	Report error and terminate task
UNIX errors creating directories	Report error and terminate task

7.3.2.4 Design

This subsection presents the design of the DID task. Figure 7-4 presents the structure chart of the DID task. The following tables identify the high level inputs and outputs of the task:.

Input

Data Item	Source	Description
0R Product	DAAC	Level 0R Image files
Directory	DIT	Ingest from tape command

Ingest 0R Files

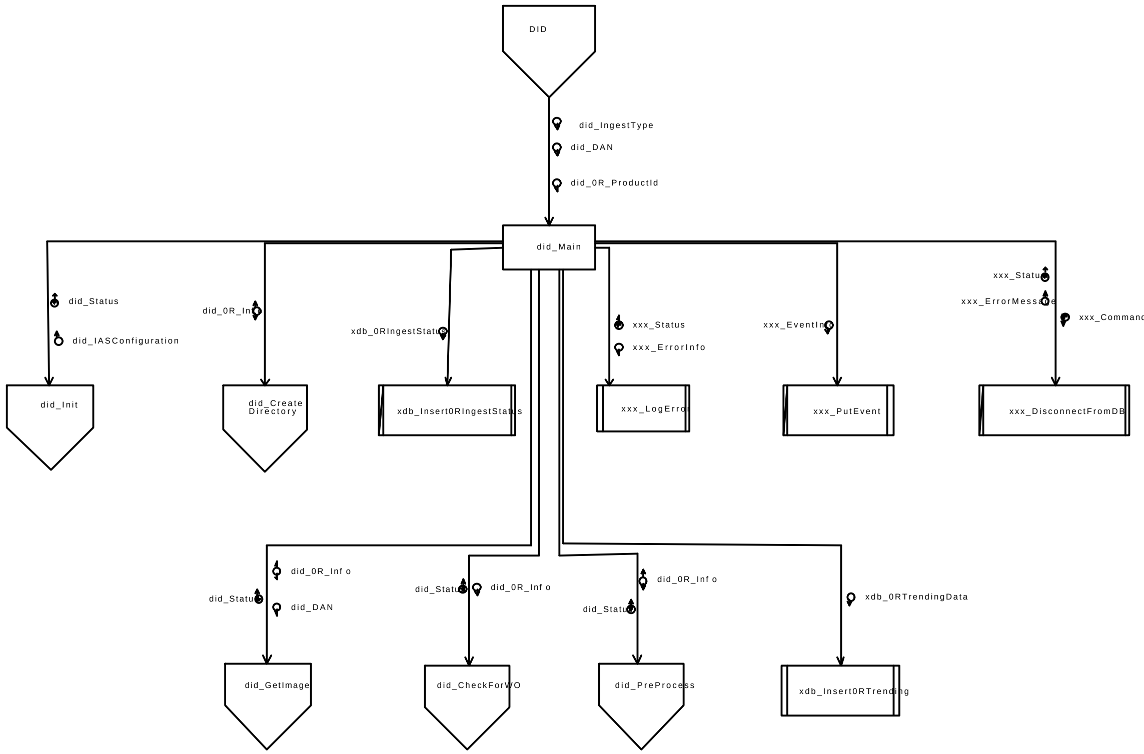

Figure 7-4. DID Task DesignControl

Control

Data Item	Source	Description
DAN	DAAC	Information about the contents of an available L0R product sent to DMS
Ingest type	DDM	Indicates what type of ingest this is (DAN or tape)

Output

Data Item	Source	Description
0R product	PCS	L0R image files
System Log	IAS disk	Log of any IAS s/w errors
Event Log	IAS DB	DID writes an event when errors occur

Algorithm

The following PDL for the unit did_Main describes the high level programming logic of the task:

```
Call did_Init() to initialize the DID task
If error initializing THEN
        ABORT to FATAL_ERROR
ENDIF

IF IngestType indicates DAN THEN
        Call did_CreateDirectory() to create the L0R product directory
        IF error creating directory THEN
                ABORT to FATAL_ERROR
        ENDIF

        Call did_GetImage() to get the L0R product files
        IF error getting L0R product THEN
                ABORT to FATAL_ERROR
        ENDIF
ELSE
        Initialize L0R path information
        Change directory to new L0R directory
        IF I/O error changing directory THEN
                Call xxx_LogError() to write the error message
                Call xxx_PutEvent() to write the event to the database
                ABORT to FATAL_ERROR
        ENDIF
        Call did_IngestStatus() to write ingest status
ENDIF
```

```
Call did_PreProcess() to preprocess the L0R product
If error preprocessing  L0R product THEN
        ABORT to FATAL_ERROR
ENDIF

FATAL_ERROR:
        Call xdb_Insert0RTrending() to insert L0R trending data
        IF database error THEN
                Call xxx_LogError() to write the error message
                Call xxx_PutEvent() to write the event to the database
        ENDIF

        Call xdb_Insert0RIngestStatus() to insert L0R product ingest status
        IF database error THEN
                Call xxx_LogError() to write the error message
                Call xxx_PutEvent() to write the event to the database
        ENDIF

        IF ingest status is not failure THEN
                Call xxx_PutEvent() to write a successful ingest notification to the database
                Call did_CheckForWO() to see if the L0R product is used in any WO
        ELSE
                Call xxx_PutEvent() to write failed ingest notification to the database
        ENDIF

        Call xxx_DisconnectFromDB() to disconnect from database
        IF database error THEN
                Call xxx_LogError() to write the error message
        ENDIF

        EXIT EXIT_SUCCESS
```

The following table lists all DID task units and their purpose:

Unit Name	Purpose
did_CalculateCaptureDirection	Calculates the capture direction
did_CalculateTempFit	Calculate the TBD temp fits
did_CheckForWO	Check to see if L0R product is associate with a WO
did_CreateDDR	Creates the DDR file
did_CreateDirectory	Creates the L0R directory
did_CreateReport	Create the L0R report file
did_FixMSCDTime	Apply the time corrections to the MSCD times
did_FixPCDTime	Apply the time corrections to the PCD times
did_GetCPFValidationInfo	Get the CPF fields needed for ingest

Unit Name	Purpose
did_GetImage	FTPs over the L0R files listed in the DAN
did_IngestMSCD	Controls the ingesting of MSCD
did_IngestPCD	Controls the ingesting of PCD
did_IngestStatus	Writes messages to the local L0R product status log
did_Init	Initialize the DID task
did_Main	Controls the DID task
did_PreProcess	Controls the ingest process
did_UpdateMSCD	Updates MSCD format 1 file with all corrections
did_UpdatePCD	Updates PCD format 1 file with all corrections
did_ValidateADS	Validates ADS
did_ValidateAttitude	Validates attitude
did_ValidateCalData	Validates band calibration files
did_ValidateCPF	Validates IAS CPF
did_ValidateEphemeris	Validates ephemeris
did_ValidateFHS_SHSError	Validates FHS/SHS
did_ValidateGeo	Validates geolocation table
did_ValidateGyro	Validates gyro
did_ValdiateGyroDrift	Validates gyro drift
did_ValidateInstrumentOnTime	Validates instrument on time
did_ValidateLineLength	Validates line length
did_ValidateMSCD	Controls the validation for MSCD file
did_ValidatePCD	Controls the validation for PCD file
did_ValidateScanDirection	Validates the scan direction
did_ValidateScanStartTime	Validate the scan start time
did_ValidateScene	Controls the validation of band/cal band data
did_ValidateSceneData	Validates the band scene data
did_ValidateSLO	Validates the scan line offset table
did_ValidateTemp	Validates the temperatures
did_ValidateTimeCorrection	Validates the time correction

7.3.3 Format Transmit Data (DFT) Task

This subsection describes the design of the DFT task software.

7.3.3.1 Initialization and Configuration

The DFT task initialization consists connecting to the database, creating a signal handler for the task, and retrieving IAS configuration information from the database. Any errors encountered during task initialization result in the DFT task's exiting prematurely.

7.3.3.2 Normal Operation

When a file(s) needs transmission, the DFT task started by DDM task transmits the file(s) to the designated facility. The DFT task first updates the status to "Starting to transmit" in the database and retrieves all the file information necessary to transmit the file(s) over to the target facility. The DFT task then ftps the file(s) over to the target facility using the egftp library units. As each file is transferred over, the database is be updated to indicated that the file was transferred.

7.3.3.3 Error Handling

The following list shows the types of errors that DFT may encounter and how DFT will process these errors

Error	Action Taken
Can’t connect to IAS DB	Report error to IAS s/w log and terminate task
Can’t read/update database	Report error and terminate task
File can’t be found	Report error and skip file
FTP problems	Skip the file and try again later for a configurable number of times
UNIX errors creating directories	Report error and terminate task

7.3.3.4 Design

This subsection presents the design of the DFT task. Figure 7-5 presents the structure chart of the DFT task. The following tables identifies the high level inputs and outputs of the task:

Control

Data Item	Source	Description
File requests	DMS	File to transmit

Output

Data Item	Source	Description
Cal_Parm_File	DAAC/MOC/LPS	Analyst requested CPF
Cal_Sched_req	MOC	Analyst requested calibration schedule request
Event Log	IAS DB	DFT writes an event when errors occur
Reports	DAAC/MOC/MMO	Analyst requested reports
System Log	IAS disk	Log of any IAS s/w errors

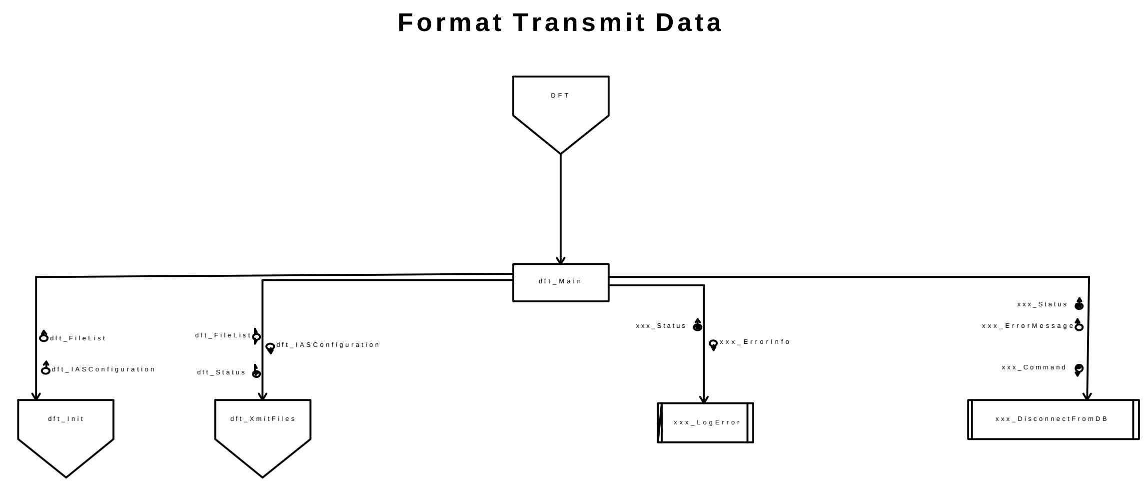

Figure 7-5. DFT Task Design

Algorithm

The following PDL for the unit dft_Main describes the high level programming logic of the task:
Call dft_Init() to initialize the DFT task

```
DOUNTIL terminated or not more files to transmit
	DOWHILE not terminated and more remote hosts or database error
			Call dft_XmitFiles() to transfer all files for that remote hosts
	ENDDO
	IF no database errors THEN
		IF some files failed to transfer over THEN
			Pause for a while
		ENDIF
	ENDIF
ENDDO

Call xxx_DisconnectFormDB() to disconnect from database
If database error THEN
	Call xxx_LogError() to log error message
ENDIF

IF database error THEN
	EXIT EXIT_FAILURE
ELSE
	EXIT EXIT_SUCCESS
ENDIF
```

The following table lists all DFT task units and their purpose:

Unit Name	Purpose
dft_GetXmitList	Gets all files waits for transmission
dft_Init	Initializes the DFT task
dft_Main	Controls the DFT task
dft_XmitFiles	FTPs over the files to the target host

7.3.4 Ingest MOC Files (DIM)

This subsection describes the operation and design of the DIM task software.

7.3.4.1 Initialization and Configuration

The DIM task initialization consists of connecting to the database, creating a signal handler for the task, and retrieving IAS configuration information from the database. Any errors encountered during task initialization result in the DIM task's exiting prematurely.

7.3.4.2 Normal Operation

During normal operation, the DIM task loops until an IAS receives a shutdown directive. Within the loop, DIM checks the MOC input ftp directory for files. When a MOC file finishes arriving, the DIM task moves the files to a permanent location on the disk. DIM converts the ephemeris files to the UNIX file format. Any definitive ephemeris files will have their first 7 minutes of data appended to the previous week's ephemeris file (this enables interpolation for points at the week boundary). DIM updates the database with the new file information.

7.3.4.3 Error Handling

The following list shows the types of errors that DIM may encounter and how DIM will process these errors:

Error	Action Taken
Can't connect to IAS DB	Report error to IAS s/w log and terminate task
Can't read/update database	Report error and continue
UNIX errors reading, creating, moving directories/files	Report error and continue

7.3.4.4 Design

This subsection presents the design of the DIM task. Figure 7-6 presents the structure chart of the DIM task..The following tables identify the high level inputs and outputs of the task

Input

Data Item	Source	Description
DIM setup	IAS DB	task setup info including polling interval, polling directory, etc.
FDF ephemeris	MOC	FDF definitive or concentrated ephemeris
MOC Reports	Reports	Reports generated by MOC. For example the MOC event report is used to identify when FASC/PASC scenes occur.

Output

Data Item	Source	Description
Ephemeris catalog	IAS DB	Summary of an ingested ephemeris file
Event Log	IAS DB	DIM writes an event when errors occur or MOC reports are received
System Log	IAS disk	Log of any IAS s/w errors

Ingest MOC Files

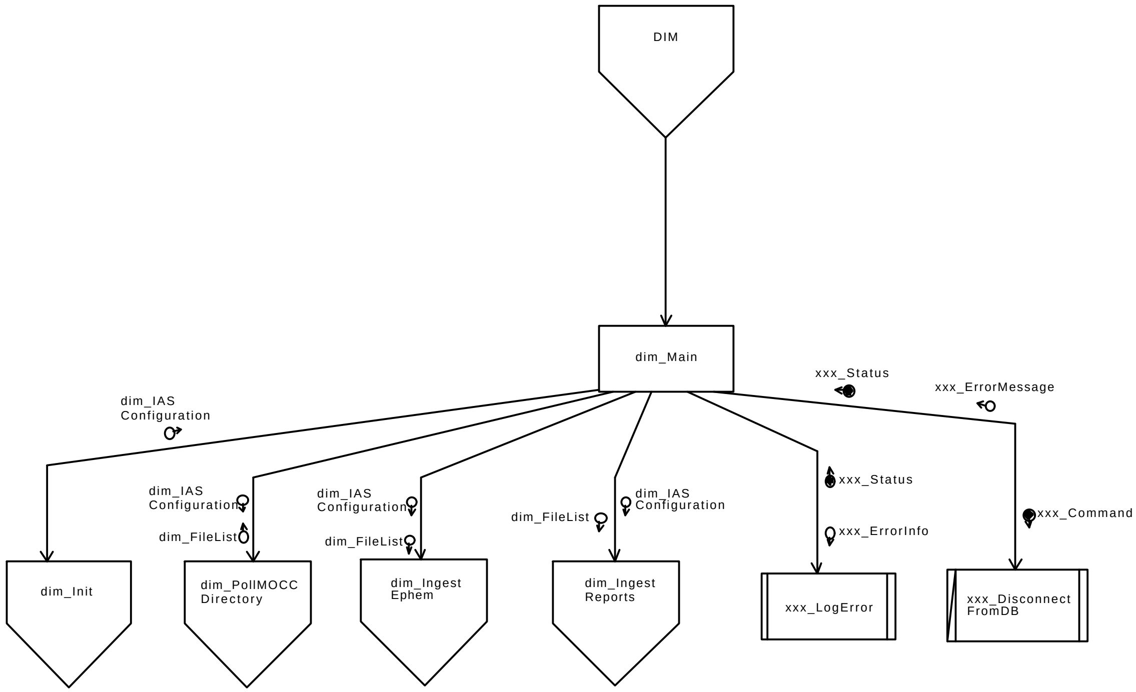

Figure 7-6. Task DIM Design

Algorithm

The following PDL for the unit dim_Main describes the high level programming logic of the task:

```
Call dim_Init() to initialize task and retrieve setup information

DOUNTIL shutdown directive received
        Call dim_PollMOCCDirectory() to identify all new files in MOC input directory
        DOFOR each file found
                IF file is ephemeris file THEN
                        Call dim_IngestEphem() to ingest MOC ephemeris file in database
                ELSE
                        Call dim_IngestReports() to store report in database
                ENDIF
        ENDDO
        Free dim_FileList
        Sleep for a while

ENDDO

Call xxx_DisconnectFromDB() to disconnect form the database
IF disconnect fails THEN
        Call xxx_LogError() to write error message to local log
ENDIF

EXIT EXIT_SUCCESS
```

The following table lists all DIM task units and their purpose:

Unit Name	Purpose
dim_IngestEphem	Ingest an ephemeris file. A definitive ephemeris file must be merged with previous week’s file
dim_IngestReports	Ingest a MOC and write an event to IAS DB to notify operator
dim_Init	Initialize the DIM task
dim_Main	Controls the DIM task
dim_MergeDefEphem	Merge current definitive ephemeris file with the previous week’s file
dim_PollMOCCDirectory	Check if MOC has ftp’d any files to the MOC input directory

7.3.5 Resource Management (DRM)

This subsection describes the operation and design of the DRM task software.

7.3.5.1 Initialization and Configuration

The DRM task initialization consists connecting to the database, creating a signal handler for the task, and retrieves IAS configuration information from the database. Any errors encountered during task initialization result in the DRM task's exiting prematurely.

7.3.5.2 Normal Operation

During normal operation, the DRM task loops until an IAS receives a shutdown directive. Within the loop, the DRM task monitors the disk usage, deletes images and WOs on request, and compares the images and WO directories against the database for mismatches.

7.3.5.3 Error Handling

The following list shows the types of errors that DRM may encounter and how DRM will process these errors:

Error	Action Taken
Can’t connect to IAS DB	Report error to IAS s/w log and terminate task
Can’t read/update database	Report error and continue
UNIX errors reading, deleting, or tarring directories	Report error and continue

7.3.5.4 Design

This subsection presents the design of the DRM task. Figure 7-7 presents the structure chart of the DRM task. The following tables identify the high level inputs and outputs of the task:

Input

Data Item	Source	Description
Control Information	Database	Identify expired WOs
Image Information	Database	Identify expired images

Control

Data Item	Source	Description
Manual Delete request	UI	Allow UI analyst to delete images or products

Output

Data Item	Source	Description
Event Log	IAS DB	DRM writes an event when errors occur
Image information	image	Delete images
System Log	IAS disk	Log of any IAS s/w errors

REVIEW

Work order detail	Work order	Delete WOs

Resource Manager

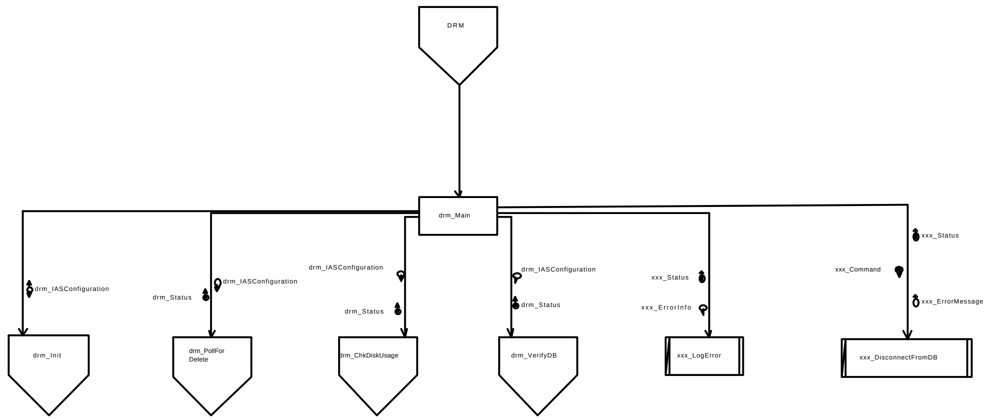

Figure 7-7. DRM Task Design.

Algorithm

The following PDL for the unit drm_Main describes the high level programming logic of the task:

```
Call drm_Init() to initialize the DRM task
DOWHILE not terminated
        IF Time to poll database THEN
                Call drm_PollForDelete() to poll database for delete commands
        ENDIF
        IF time to check disk usage THEN
                Call drm_ChkDiskUsage() to check the disk usage
        ENDIF
        IF time to verify disk THEN
                Call drm_VerifyDB() to verify the disk against the database
        ENDIF
ENDDO

Call xxx_DisconnectFromDB() to disconnect from database
IF database error THEN
        Call xxx_LogError() to log error message
ENDIF
```

EXIT_SUCCESSThe following table lists all DRM task units and their purpose:

Unit Name	Purpose
drm_ChkDiskUsage	Check the disk usage
drm_Init	Initialize the DRM task
drm_Main	Controls the DRM task
drm_PollForDelete	Check the database for files to delete
drm_VerifyDB	Verify the database against the hard disk

7.3.6 Ingest From Tape (DIT)

This subsection describes the operation and design of the DIT task software.

7.3.5.1 Initialization and Configuration

The DIT task initialization consists of parsing the user command, connecting to the database, creating a signal handler for the task, and retrieves IAS configuration information from the database. Any Errors encountered during task initialization result in the DIT task's exiting prematurely.

7.3.5.2 Normal Operation

The DIT task is a one shot utility started on the UNIX command line. It allows the user to either reset a L0R product's delete flag to "not deleted" or send a start ingesting from tape command to the DDM task. The user will first manually make the L0R directory on the product partition and restore the L0R product files from tape. The user will then start up the DIT task using the option flags. The DIT task will parse the option flags and either update the product's delete flag to "not deleted" in the database or open a socket connection to the DDM task and write the start ingesting from tape command. The DIT task writes an event to the database indicating the completion of the DIT operation.

7.3.5.3 Error Handling

The following list shows the types of errors that DIT may encounter and how DIT will process these errors:

Error	Action Taken
Can't connect to IAS DB	Report error to IAS s/w log and terminate task
Can't read/update database	Report error and terminate task
DAAC key is not in the database for "un-delete L0R"	Report error and terminate task
File can't be found	Report error and terminate task

7.3.5.4 Design

This subsection presents the design of the DIT task. Figure 7-8 presents the structure chart of the DIT task. The following tables identify the high level inputs and outputs of the task:

Input Control

Data Item	Source	Description
Directory	User Interface	DAAC directory name to ingest or update

Output

Data Item	Source	Description
Directory	DDM	0R directory to ingest
0R product delete flag	database	Update delete flag to "not deleted"
Reports	DAAC/MOC/MMO	Analyst requested reports
System Log	IAS disk	Log of any IAS s/w errors
Event Log	IAS DB	DIT writes an event when errors occur

Ingest from LPS Tape

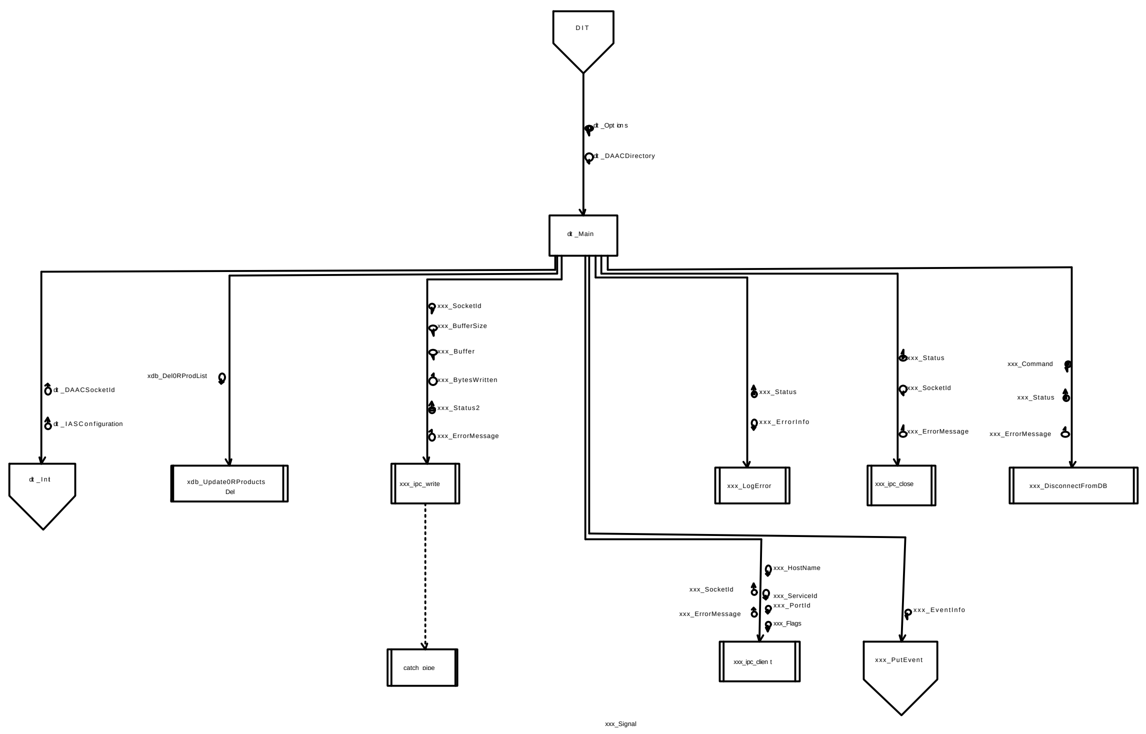

Figure 7-8. DIT Task Design

Algorithm

The following PDL for the unit dit_Main describes the high level programming logic of the task:

Initializes variables

```
DOWHILE more arguments
    Call getopt() to get the next option
    DOCASE option
    CASE update:
        Set update flag
    CASE DAAC directory name:
        Extract DAAC directory name
    ELSE
        Write the usage error message to standard out
        EXIT
    ENDDO
ENDDO
IF the p_DAACDirectory argument is missing THEN
    Write the usage error message to standard out
ELSEIF the p_DAACDirectory does not exist THEN
    Write the directory does not exist message to standard out
ELSE
    Call did_Init() to initialize the DIT task
    IF update flag is set THEN
        Call xdb_Update0RProductDel() to update the L0R product
        IF database error THEN
            Call xxx_LogError() to log error message
            Write the error message to standard out
        ENDIF
    ELSE
        Call xxx_ipc_client() to create DAAC client socket
        If write error THEN
            Call xxx_LogError() to log error message
            Write the error message to standard out
        ELSE
```

```
                Call xxx_ipc_write() to write the start LPS tape ingest command for
                  p_DAACDirectory
                If write error THEN
                    Call xxx_LogError() to log error message
                    Write the error message to standard out
                ENDIF
                Call xxx_ipc_close() to close the DAAC socket
            ENDIF
            IF no errors THEN
                Call xxx_PutEvent() to write operation success event to the database
                Write the DAAC command set OK message to standard out
            ELSE
                Write the command failed message to standard out
            ENDIF
        ENDIF
ENDIF

Call xxx_DisconnectFromDB() to disconnect from the database
IF database error THEN
    Call xxx_LogError() to log error message
ENDIF

EXIT EXIT_SUCCESS
```

The following table lists all DIT task units and their purpose:

Unit Name	Purpose
dit_Init	Initialize the DIT task
dit_Main	Execute the user command

7.3.7 Generate Calibration Parameter File (DGC)

This subsection describes the design of the DGC task software.

7.3.7.1 Initialization and Configuration

The DGC task initialization consists of parsing the user command, connecting to the database, creating a signal handler for the task, and retrieves IAS configuration information from the database. Any Errors encountered during task initialization result in the DGC task's exiting prematurely.

7.3.7.2 Normal Operation

The DGC task is a one shot a utility started either on the UNIX command line or via the user interface. When the geometry and/or radiometry analysts finish changing their fields, the

DGC task is started up to merge those changes into the base CPF. The new CPF is then written to the disk. A log of what changes were made is generated to disk. DGC inserts the new CPF information into the database. The DGC task exits.

7.3.7.3 Error Handling

The following list shows the types of errors that DGC may encounter and how DGC will process these errors:

Error	Action Taken
Can't connect to IAS DB	Report error to IAS s/w log and terminate task
Can't read/update database	Report error and terminate task
ODL errors	Report error and terminate task
UNIX errors	Report error and terminate task

7.3.7.4 Design

This subsection presents the design of the DGC task. Figure 7-9 presents the structure chart of the DGC task. The following table identifies the high level inputs and outputs of the task:

Input

Data Item	Source	Description
Cal_Parm_File Control Files	Disk	ODL file that defines what fields in the Control Files CPF can be updated by radiometry and geometry, Geometry CPF updates, Radiometry CPF updates, and default CPF
File_Locations	Database	Location of Cal_Parm_File Control Files

Output

Data Item	Source	Description
Catalog CPF	Database	Calibration generation information
Cal_Parm_File	Disk	New CPF
System Log	IAS disk	Log of any IAS s/w errors
Event Log	IAS DB	DGC writes an event when errors occur

Generate Calibration Parameter File

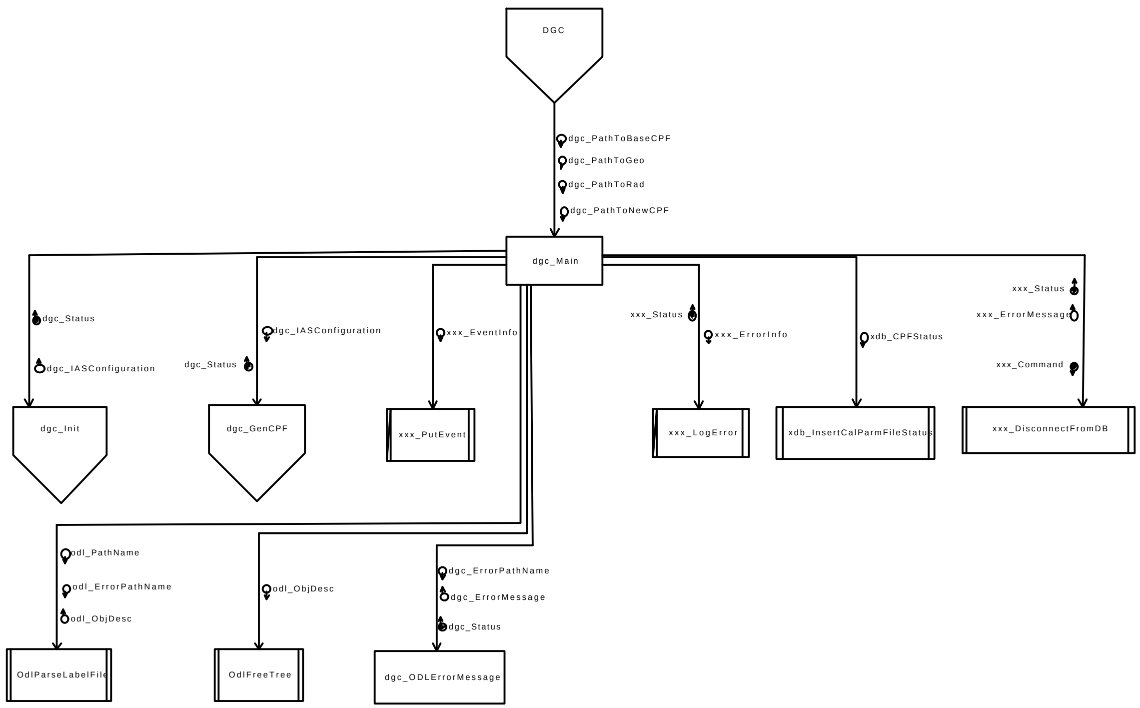

Figure 7-9. DGC Task Design

REVIEW

Algorithm

The following PDL for the unit dgc_Main describes the high level programming logic of the task:

```
Set exit status to EXIT_FAILURE

Call dgc_Init() to initialize the DGC task
If error initializing THEN
        ABORT to FATAL_ERROR
ENDIF

DOWHILE more arguments
        Call getopt() to get the next option
        DOCASE option
        CASE base CPF path:
                Extract the base CPF path
                Call OdlParseLabelFile() to parse in the base CPF file
                IF parse failed THEN
                        dgc_ODLErrorMessage() to get ODL error
                        Call xxx_LogError() to log error message
                        Call xxx_PutEvent() to write event to database
                ENDIF
        CASE geometry path:
                Extract the geometry path
                Call OdlParseLabelFile() to parse in the geometry CPF file
                IF parse failed THEN
                        dgc_ODLErrorMessage() to get ODL error
                        Call xxx_LogError() to log error message
                        Call xxx_PutEvent() to write event to database
                ENDIF

        CASE radiometry path:
                Extract the radiometry path
                Call OdlParseLabelFile() to parse in the radiometry CPF file
                IF parse failed THEN
                        dgc_ODLErrorMessage() to get ODL error
                        Call xxx_LogError() to log error message
                        Call xxx_PutEvent() to write event to database
                ENDIF
        CASE new CPF path:
                Extract the new CPF path
        ELSE
                Call xxx_LogError() to log error message
                Call xxx_PutEvent() to write event to database
```

```
        ABORT to FATAL_ERROR
    ENDDO
ENDDO

IF don't have all arguments THEN
    Call xxx_LogError() to log error message
    Call xxx_PutEvent() to write event to database
ENDIF

IF don't have all arguments or error in arguments THEN
    Call odlFreeTree() to free files
    ABORT to FATAL_ERROR
ENDIF

Call dgc_GenCPF() to merge geometry/radiometry file(s) into the CPF
IF CPF file created successfully THEN
    Call xdb_InsertCalParmFileStatus() to insert the CPF creation status
    IF database error THEN
        Call xxx_LogError() to log error message
        Call xxx_PutEvent() to write event to database
    ELSE
        Set exit status to EXIT_SUCCESS
    ENDIF
ENDIF

FATAL_ERROR:
    Call xxx_DisconnectFromDB() to disconnect from database
    IF database error THEN
        Call xxx_LogError() to log error message
    ENDIF

    EXIT exit status
```

The following table lists all DGC task units and their purpose:

Unit Name	Purpose
dgc_GenCPF	Merges in the changes and writes out new CPF
dgc_Init	Initialize the DGC task
dgc_LogField	Log what was changed
dgc_Main	Execute the user command
dgc_ODLErrorMessage	Gets the ODL error message from the error file

Section 8. Radiometric Process Subsystem

8.1 Introduction

The Radiometric Processing Subsystem (RPS) implements IAS's radiometry algorithms. These algorithms are used to identify the presence of various artifacts in the L0R data sets and to characterize the radiometric performance of the Landsat 7 ETM+ instrument. The algorithms are also used radiometrically correct the datasets, resulting in the generation of L1R images. Radiometric calibration parameters are derived from these characterizations and are stored in the CPF.

8.2 Design Overview

This section provides an overview of the RPS software design. The relationship between the RPS and other IAS subsystems is presented, along with a software task model representing the interdependency among RPS software components and a discussion of the assumptions, constraints, and considerations used in the design process.

8.2.1 Subsystem Software Overview

Figure 8-1 contains the context diagram of RPS. As shown, RPS receives user-specified processing parameters from the PCS. These parameters specify, among other things, the image bands that are to be processed and the characterizations and corrections that are to be applied to these bands. The primary data inputs - the L0R product files - are staged by the DMS. The image datasets generated during RPS task execution are stored by the DMS. Other outputs, including text reports and plots, and data for trending are stored in WO directories or in the IAS Trending Database for later analysis by an IAS Analyst using functions provided by the E&A.

8.2.2 Design Considerations

8.2.2.1 Design Assumptions

This subsection presents important assumptions made during the design process.

- Radiometry algorithms are to be executed in a fixed sequence, as depicted in the process flows presented in Appendix C.

- Radiometry algorithms all process a single image band at a time.

- Radiometric characterizations and associated corrections (i.e., specific algorithms) can be individually enabled or disabled for a given run.

•

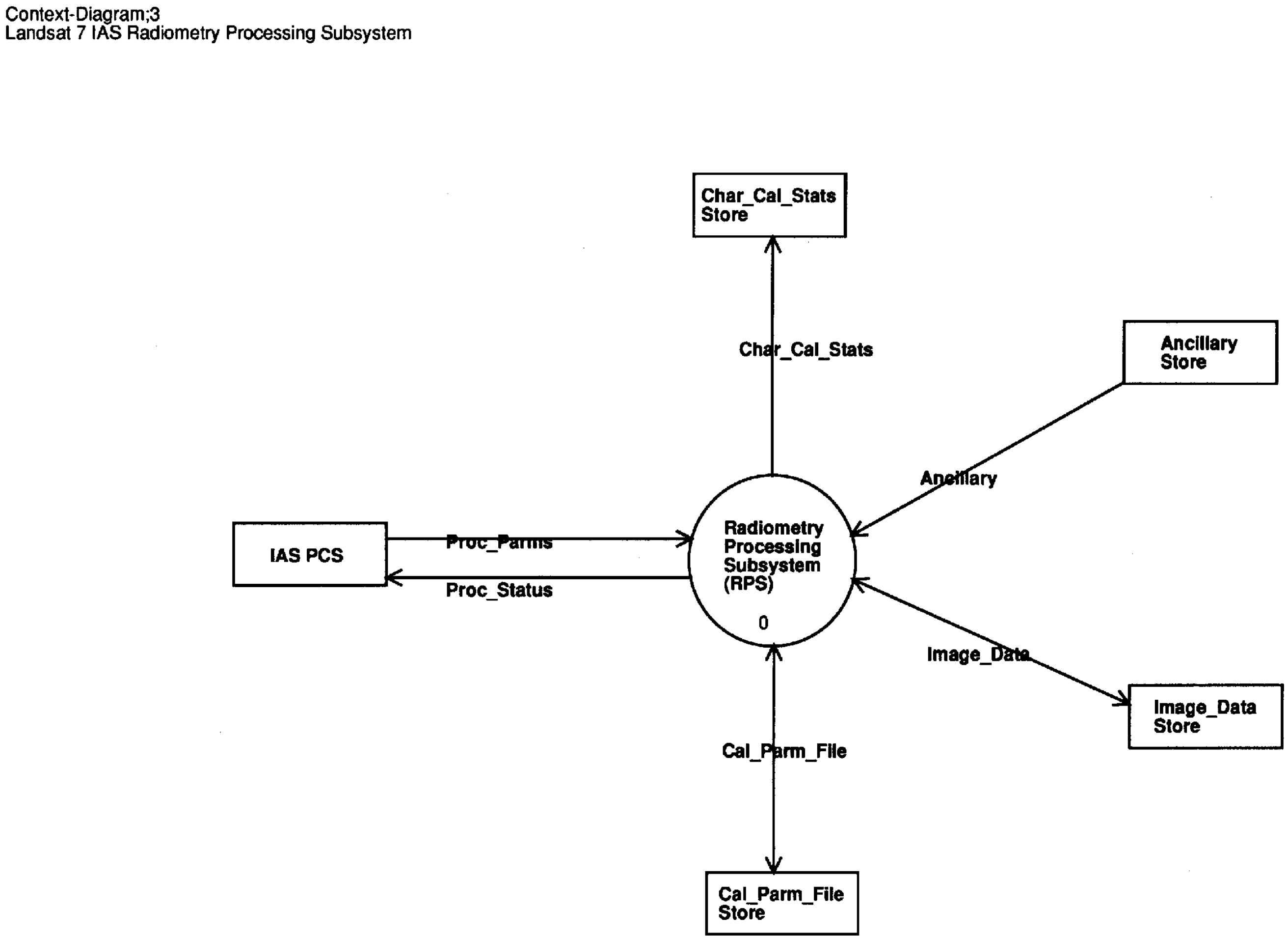

Figure 8-1. RPS Context Diagram

8.2.2.2 Subsystem Support of Operational Scenarios

Table 8-1 maps the RPS-related operational scenarios to the supporting tasks. These scenarios are presented in Section 4 of this document

Table 8-1. RPS-related Operational Scenarios

Operational Scenario	Support Level
Process WO	Major

8.2.2.3 Software Reuse Strategy

This subsection identifies external components that may be reused by the RPS.

The RPS comprises primarily new custom software. This is necessitated by the presence of 2 new calibrators - the Partial Aperture Solar Calibrator (PASC) and the Full Aperture Solar Calibrator (FASC) - on the instrument. The designs, and potentially specific code fragments, of algorithm prototypes developed in support of algorithm development will be used to the extent practical.

RPS will also make extensive use of IAS global routines developed for specialized data I/O and for database interaction.

8.2.3 Open Issues

This subsection presents important issues that remain unresolved at this point in the design phase.

- Two radiometry algorithms remain in a state of development. These are Characterize Memory Effect and Characterize Coherent Noise.

- The algorithm for the Combined Radiometric Model (CRaM) is not yet well understood by the Algorithm Implementation Team (AIT).

- The processing flows depicted in Appendix C require further review. Changing the order of algorithm execution may reduce duplicate operations and increase the efficiency of system operation.

- The transformation of image data from byte to floating point to 2 byte integer formats, as well as from digital numbers (DN) to absolute radiance, is not well understood by the AIT.

These issues impact the software design and will not be resolved during the detailed design .

8.3 Subsystem Design

This subsection provides a detailed description of the RPS software task model selected to implement the RPS design. The RPS software is designed as a single SWCI that satisfies all of the IAS element requirements allocated to RPS.

The transforms presented in the RPS essential model are grouped into four software tasks that execute in sequence. The RPS task model, shown in Figure 8-2, consists of the following tasks:

- r0r - Characterize and Correct L0R Images
- r0c - Characterize and Correct L0Rc Images
- r1r - Characterize and Correct L1R Images
- rCR - Combined Radiometric Model

The design of these tasks is presented below.

8.3.1 Level 0R Characterization and Correction (r0r) Task

This subsection describes the operation and design of the r0r task software.

8.3.1.1 Initialization and Configuration

Task r0r is initiated by the PCS. As part of task initialization, it accesses the user-specified parameters to determine which images bands to process and which characterizations to execute during this invocation. It then allocates memory to hold an entire L0R band of imagery - both scene and Internal Calibrator (IC) data - and reads the band into memory. This is done to minimize I/O by eliminating the need for each algorithm to read in the large band files.

8.3.1.2 Normal Operation

During nominal operations, the individual algorithms depicted in Appendix C are executed in sequence. The characterization algorithms primarily identify the locations of pixels that are to be ignored during “downstream” processing. Characterized artifacts include missing minor frames, impulse noise, and saturated detectors. The correction algorithms correct for scan-correlated shift, memory effect, and coherent noise. Which specific algorithms are executed depends on both the type of scene (i.e., day, night, PASC, or FASC) and on the user selections. The end result of the execution is a floating point L0Rc image, a set of ASCII reports summarizing the results of the characterizations performed, and a set of trending statistics stored in the IAS Trending Database.

Figure 8-2. RPS Task Model (TBS)

8.3.1.3 Error Handling

The following list shows the types of errors that r0r may encounter and how r0r will handle these errors:

Error	Action Taken
Can’t connect to IAS DB	Report error to WO log and exit process
Can’t read L0R input files from disk	Report error to WO log and exit process
Can’t write L0Rc output files to disk	Report error to WO log and exit process

8.3.1.4 Design

This subsection presents the design of the r0r task. Figure 8-3 presents the structure chart of the r0r task. The following table identifies the high level inputs and outputs of the task:

Input

Data Item	Source	Description
CPF	IAS Disk - RPS/User	User-selected CPF to be used in L1R processing
L0R Product	IAS Disk (DMS)	L0R product files to be characterized and corrected
ODL Parameter File Name	PCS	Name of the ODL file containing user-specified WO parameters. Passed on the command line to the r0r task.
Parameter File	IAS Disk (PCS)	The actual ODL file containing user-specified WO parameters

Output

Data Item	Destination	Description
L0Rc files	IAS disk (r0c)	L0R corrected data
LMask	IAS disk (r0c)	Dataset identifying locations of certain image artifacts
Trending Data	IAS DB (E&A)	Trending data used by E&A to evaluate ETM+ performance
WO Log	IAS disk	Log of r0r execution messages

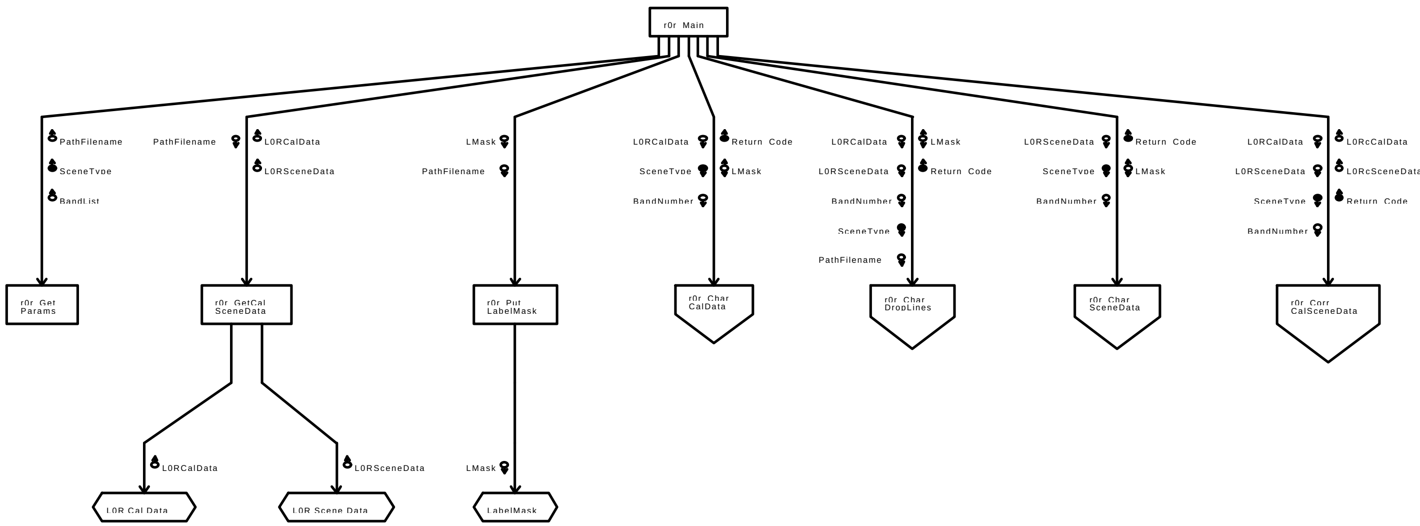

Figure 8-3. r0r Structure Chart

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The following M-Spec for the unit r0r_Main describes the high-level programming logic of the task:

1.0 Call r0r_GetParams to get pathfilename, scene type and band list

2.0 For each band do the following

  2.1 Call r0r_GetCalSceneData to read in scene and cal data for this band

  2.2 If return code indicated an error ocurred during processing

    2.2.1 Print a description of error

    2.2.2 Exit program

  2.3 Call r0r_CharDropLines

  2.4 Call r0r_CharCalData to characterize Calibration data

  2.5 If return code indicated an error ocurred during processing

    2.5.1 Print a description of error

    2.5.2 Exit program

  2.6 Call r0r_CharSceneData to characterize Scene data

  2.7 If return code indicated an error ocurred during processing

    2.7.1 Print a description of error

    2.7.2 Exit program

  2.8 Call r0r_CorrCalSceneData to correct Cal and Scene data

  2.9 If return code indicated an error ocurred during processing

    2.9.1 Print a description of error

    2.9.2 Exit program

  2.10 Call r0r_PutLabelMask to output label mask to file

The following table lists the r0r task units and their purpose:

Unit Name	Purpose
r0r_CharCalData	Control execution of algorithms for characterizing IC data
r0r_CharDropLines	Locate missing minor frames
r0r_CharSceneData	Control execution of algorithms for characterizing scene data
r0r_CorrCalSceneData	Control execution of correction algorithms
r0r_GetCalSceneData	Read L0R IC and scene data from disk
r0r_GetParams	Get user-specified WO parameters
r0r_Main	Control algorithm execution
r0r_PutCalSceneData	Write L0Rc IC and scene data to disk
r0r_PutLabelMask	Write Label Mask to disk

8.3.2 L0Rc Characterization and Correction (r0c) Task

This subsection describes the operation and design of the r0c task software.

8.3.2.1 Initialization and Configuration

Task r0c is initiated by the PCS following the completion of execution of the r0r task. As part of task initialization, it accesses the user-specified parameters to determine which images' bands to process and the source of the gains and biases to be applied during this invocation. It then allocates memory to hold an entire L0Rc band of imagery - both scene and IC data - generated by the r0r task and reads the band into memory. This is done to minimize I/O by eliminating the need for each algorithm to read in the large band files.

8.3.2.2 Normal Operation

During nominal operations, the individual algorithms depicted in Appendix C are executed in sequence. Which specific algorithms are executed depends on both the type of scene (i.e., day, night, PASC, or FASC) and on the user selections. The key outputs of the task are gains and biases derived from the processing of IC, FASC, and PASC data, and a radiometrically corrected floating point L1R image. Also generated are ASCII reports summarizing the results of the characterizations performed and a set of trending statistics stored in the IAS Trending Database.

8.3.2.3 Error Handling

The following list shows the types of errors that r0r may encounter and how r0r will handle these errors:

Error	Action Taken
Can't connect to IAS DB	Report error to WO log and exit process
Can't read L0Rc input files from disk	Report error to WO log and exit process

Error	Action Taken
Can’t write L1R output files to disk	Report error to WO log and exit process

8.3.2.4 Design

This subsection presents the design of the r0c task. Figure 8-4 presents the structure chart of the r0c task. The following table identifies the high level inputs and outputs of the task:

Input

Data Item	Source	Description
ODL Parameter File Name	PCS	Name of the ODL file containing user-specified WO parameters. Passed on the command line to the r0r task.
Parameter File	IAS Disk (PCS)	The actual ODL file containing user-specified WO parameters
L0Rc Product	IAS Disk (DMS)	L0R ancillary and L0Rc corrected image files to be characterized and radiometrically corrected
LMask	IAS disk (r0r)	Dataset identifying locations of certain image artifacts
CPF	IAS Disk - RPS/User	User-selected CPF to be used in L1R processing

Output

Data Item	Destination	Description
L1R files	IAS disk (r1r)	Radiometrically corrected L1R image files
LMask	IAS disk (r1r)	Dataset identifying locations of certain image artifacts
Trending Data	IAS DB (E&A)	Trending data used by E&A to evaluate ETM+ performance
WO Log	IAS disk	Log of r0c execution messages

The following M-Spec for the unit r0c_Main describes the high-level programming logic of the task:

1.0 Call xxx_Init(ODL_Ident) to set global variables and create file descriptors for PCD, MSCD, and geolocation

2.0 Call xxx_GetParams to get band numbers to be processed

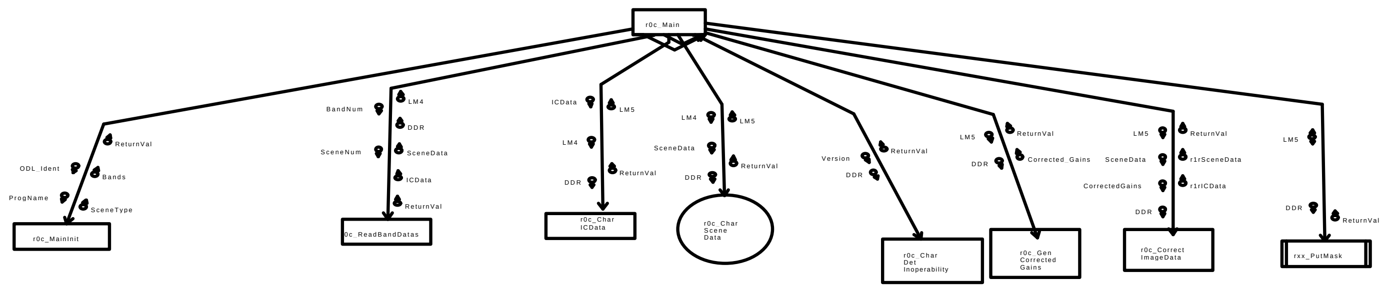


Figure 8-4. r0c Structure Chart

3.0 If GetParams error return Error

4.0 If init error return Error

5.0 For each band to pr ocess do:

5.1 Call rxx_GetMask(LM4, BandNum)

5.2 If unable to get mask return Error

5.3 Call xxx_ReadImagery for both IC and Scene data

5.4 If unable to read imagery, return Error

5.6 For each scene do:

5.6.1 Call rxx_Init to create DDR with passable data

5.6.2 Call r0c_CharICData(LM4,ICData, DDR)

5.6.3 Call r0c_CharDetInoperability(Version, DDR)

5.6.4 Call r0c_CharSceneData(LM4,SceneData, DDR)

5.6.5 Call r0c_GenCorrectedGains(LM5, DDR)

5.6.6 Call r0c_CorrectImageData(LM5, ICData, SceneData, CorrectedGains, DDR)

5.6.7 Call rxx_PutMask(LM5, DDR)

5.6.8 Call xxx_WriteImagery

End Do

End For

6.0 Close file descriptors

The following table lists all r0c task units and their purpose:

Unit Name	Purpose
r0c_CharDetInoperability	Characterize detector inoperability
r0c_CharICData	Control execution of algorithms for characterizing IC data
r0c_CharSceneData	Control execution of algorithms characterizing scene data
r0c_CorrectImageData	Applies gains and offsets to image data
r0c_GenCorrectedGains	Generates corrected gain values
r0c_Main	Control algorithm execution
r0c_MainInit	Perform task initialization
r0c_ProcessPASC	Controls processing of PASC data
r0c_ReadBandData	Read image band data from disk

8.3.3 Level 1R Characterization and Correction (r1r) Task

This subsection describes the operation and design of the r1r task software.

8.3.3.1 Initialization and Configuration

Task r1r is initiated by the PCS following the completion of execution of the r0c task. As part of task initialization, it accesses the user-specified parameters to determine which images bands to process and the cosmetic corrections to be applied during this invocation. It then allocates memory to hold an entire L1R band of imagery - both scene and IC data - generated by the r0c task and reads the band into memory. This is done to minimize I/O by eliminating the need for each algorithm to read in the large band files.

8.3.3.2 Normal Operation

During nominal operations, the individual algorithms depicted in Appendix C are executed in sequence. Which specific algorithms are executed depends on both the type of scene (i.e., day, night, PASC, or FASC) and on the user selections. The primary output is a cosmetically corrected L1R image.

8.3.3.3 Error Handling

The following list shows the types of errors that r0r may encounter and how r0r will handle these errors:

Error	Action Taken
Can’t connect to IAS DB	Report error to WO log and exit process
Can’t read L1R input files from disk	Report error to WO log and exit process
Can’t write corrected L1R files to disk	Report error to WO log and exit process

8.3.3.4 Design

This subsection presents the design of the r1r task. Figure 8-5 presents the structure chart of the r1r task. The following table identifies the high level inputs and outputs of the task:

Input

Data Item	Source	Description
CPF	IAS Disk - RPS/User	User-selected CPF to be used in L1R processing
L1R Product	IAS Disk (DMS)	L1R image files to be characterized and cosmetically corrected
LMask	IAS disk (r0c)	Dataset identifying locations of certain image artifacts
ODL Parameter File Name	PCS	Name of the ODL file containing user-specified WO parameters. Passed on the command line to the r0r task.
Parameter File	IAS Disk (PCS)	The actual ODL file containing user-specified WO parameters

Output

Data Item	Destinatio n	Description
L1Rc files	IAS disk (0Rc)	L1R corrected data
Trending Data	IAS DB (E&A)	Trending data used by E&A to evaluate ETM+ performance
WO Log	IAS disk	Log of r1r execution messages

The following M-Spec for the unit r1r_Main describes the high-level programming logic of the task:

1. Get user parameters for processing the scene: construct input file names, list of bands, scene type (rxx_GetParms).

2. Read IC data and send it to Characterize Random Noise (alg. 2.9).

3. Loop on bands to be processed (r1r_Corrections):

    a. Read band into memory.

    b. Call histogram analysis (alg. 2.10).

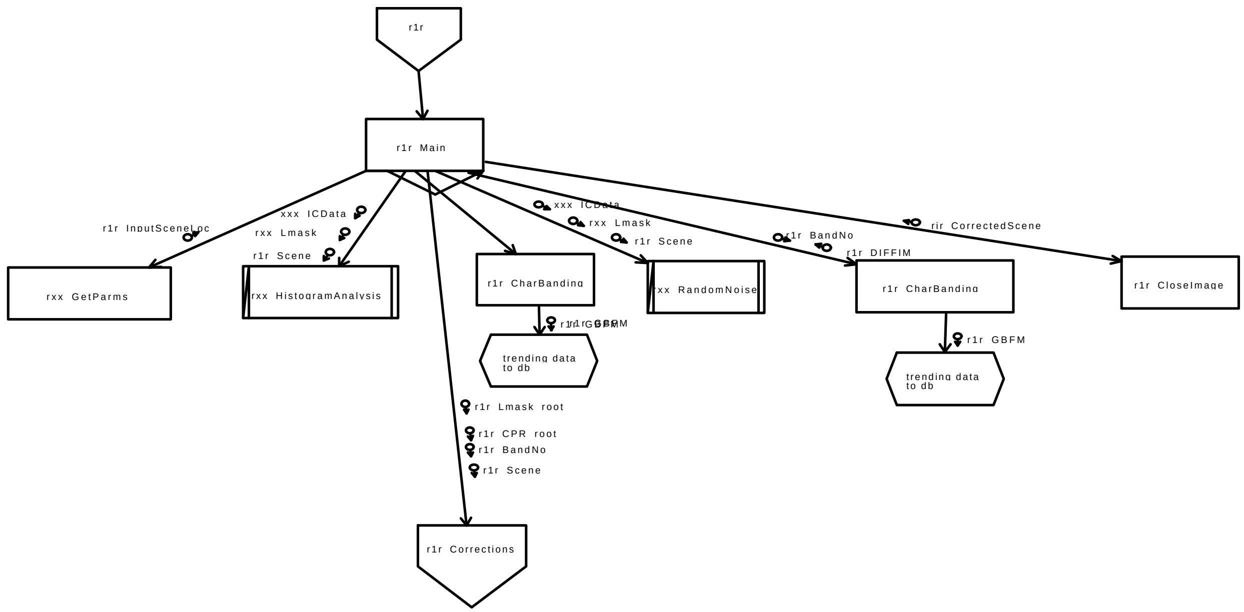


Figure 8-5. r1r Structure Chart

c. Case (Scene Type) [switch statement in C]

Day Scene : Call Correct Inoperable Detectors (alg. 4.321)
Call Correct Dropped Lines (alg. 4.3.1)
Call Characterize Banding (alg. 4.3.5)
If scenario 2 then
Call Correct Banding (alg. 4.3.5)
Endif

Night Scene: Call Correct Inoperable Detectorss (alg. 4.321)
Call Correct Dropped Lines alg. 4.3.1))
Call Characterize Banding (alg. 4.3.5)

PASC Scene: Call Characterize Banding (alg. 4.3.5)

FASC Scene: Call Characterize Banding (alg. 4.3.5)
Call Characterize Random Noise (alg. 2.9)

d. Convert band from floating point to two byte integer and output band (r1r_CloseImage) .

.

The following table lists all r1r task units and their purpose:

Unit Name	Purpose
r1r_Banding	Characterizes and corrects for banding
r1r_Corrections	Corrects for missing minor frames and impulse noise
r1r_Main	Controls task execution
r1r_Striping	Corrects for striping
r1rCloseImage	Closes image files
rxx_HistogramAnalysis	Perform histogram analysis
rxx_RandomNoise	Characterize Random Noise

8.3.4 Combined Radiometric Model (rCR) Task

The design of the CRaM task is TBD.

SECTION 9. Geometric Processing Subsystem

9.1 Introduction

The Geometric Processing Subsystem (GPS) provides all the functionality required for Level 1G product generation, geometric calibration, geometric characterization and evaluation. This system implements all of the IAS geometry algorithms.

Th*e Landsat 7 Image Assessment System Geometric Processing Subsystem Detailed Design Specification* contains the detailed design material for GPS.

Section 10. Evaluation & Analysis Subsystem

10.1 Introduction

This section provides an overview of the Evaluation and Analysis Subsystem (E&A) software design. The relationship between the E&A and other IAS subsystems is presented, along with a discussion of the assumptions, constraints, and considerations used in the design process.

10.2 Design Overview

This section describes the E&A. The E&A provides the tools required by an IAS Analyst to evaluate and analyze ETM+ instrument performance, perform anomaly investigations, and maintain the CPF. Included are capabilities for: viewing system inputs, processing reports, data analysis, statistical analysis and trending; and report generation. Also included are capabilities for editing system inputs and intermediate results and for submitting processing requests in support of “what if?” analyses.

10.2.1 Subsystem Software Overview

The E&A interfaces to the RPS and GPS indirectly through the algorithms' input and output datasets. Algorithm inputs, including L0R image data, IC data, GCP libraries, etc., are retrieved by E&A from designated run directories for viewing. The Analyst may use E&A capabilities to edit these inputs and rerun the processing using the WO mechanism. Algorithm execution results, including characterization and calibration summary reports and statistics for trending, are input to E&A. Other statistics are input to E&A via the trending database. All intermediate files generated by these algorithms including 0Rc, 1R, and 1G image files as well as GCP residual files, precision solution files, etc., are retrieved by E&A from designated run directories for viewing.

E&A generates reports on a monthly, quarterly, or annual basis for distribution to the MMO via the DAAC. E&A interfaces with the PCS in two ways: (1) through notifications from the PCS of WOs pending Analyst's action, and (2) WOs submitted by an Analyst to the PCS for "what if" analyses.

10.2.2 Design Considerations

This sections describes the design considerations used while developing the E&A.

10.2.2.1 Assumptions

It is assumed that proposed hardware and operating system will support IDL, ENVI and FrameMaker.

10.2.2.2 Open Issues

none

10.2.2.3 Operational Support

The E&A software performs the following operations:

- ASCII and image file display
- Formatted dumps and hardcopy outputs of images
- Editing of system input and output files, including image and Calibration Parameter files
- Image analysis
- Statistical and trending analysis
- Report generation
- Screen display of all plots/reports
- Access to custom IAS applications for radiometric and geometric assessment and evaluation
- Access to WO submission mechanism

10.2.2.4 Software Reuse Strategy

The subsystem software is comprised almost exclusively of COTS products.

10.2.3 Subsystem Error Handling

TBD

10.3 Subsystem Design

The E&A consists primarily of an integrated set of commercial-off-the-shelf (COTS) software packages: ENVI, IDL, and FrameMaker. ENVI provides the basic menu-driven GUI as well as the majority of the data processing tools required of the E&A. Additionally required IDL functionality is made accessible by means of customized ENVI menus. ENVI itself is implemented in IDL and is designed for such customization. The ability to activate external applications such as FrameMaker and Oracle is also provided via ENVI menus. Access to custom IAS applications for radiometric and geometric assessments and evaluation are provided via the ENVI GUI.

Access to Oracle forms for WO submission and database queries is also provided via the ENVI GUI. FrameMaker, also invoked from the GUI, is used to generate the trending, calibration, assessment, evaluation, and anomaly resolution reports.

Additional tasks are needed to supply required E&A functionality that is not built into ENVI. These are: (1) retrieve data from the Oracle database into IDL, (2) view L0R ingest reports, (3) perform Impulse Noise analysis, (4) perform Coherent Noise analysis, (5) perform Random Noise analysis, (6) perform gain-fitting for the CRaM, (7) perform evaluation of the “Correct Coherent Noise” algorithm, and (8) perform trending analysis.

10.3.1 ENVI - The Environment for Visualizing Images

10.3.1.1 Task Overview

ENVI is a COTS package that provides the user interface for the IAS Analyst as well as the majority of the data processing tools required of the E&A.

10.3.1.2 Initialization

ENVI is initialized by invoking the application from the UNIX command line. This is done after X Windows is up and running on the display.

10.3.1.3 Normal Operation

ENVI will normally be running at all times to provide the user interface for the IAS Analyst. All functionality required by the Analyst will be accessed through the ENVI menu environment. This includes core ENVI functionality, custom IDL functionality, Oracle forms for database queries and WO submissions, FrameMaker for report generation, and simple text editors/viewers for viewing WOs pending, Run Log output, etc. The use of the ENVI interface is by nature highly interactive.

10.3.1.4 Design, Input, Output, Algorithm

ENVI is implemented in IDL and provides an extensive and customizable menu-driven interface to its functionality. The input, output, and algorithm used depend on the particular function chosen.

10.3.2 Retrieve Data from the Oracle Database into IDL

10.3.2.1 Task Overview

This task imports data into IDL variables from the Oracle database (e.g., trending data) in order to enable the Analyst to visualize and analyze these data using core IDL functions. This task is designed to facilitate the use of custom IDL applications that are not specifically part of the ENVI software package (these functions already have associated data I/O capabilities).

10.3.2.2 Initialization

This task is initialized by the custom IDL application (e.g., trending analysis) that requires data from the database. The application passes to the task the required query information and the variables to be loaded.

10.3.2.3 Normal Operation

Normally this task is invoked from within other applications that require data from the database. The application is responsible for obtaining the query information (e.g., through a GUI) and passing it to this task.

10.3.2.4 Design

This task is designed as an IDL procedure callable by other IDL applications. Input to the task is the information specifying the query to be made in the form of text strings, as well as the variables to be loaded. Output from the task are the loaded variables. The algorithm is as follows: After the query information and variables to be loaded are passed to the task, it builds a file containing the query information in the proper format for Oracle, spawns an Oracle process passing the filename as an argument, and monitors the spawned process. After determining that the spawned process has completed, the task opens the output file generated by Oracle and places the data retrieved into IDL variables, which are then passed back to the calling application.

10.3.3 View L0R Ingest Reports

10.3.3.1 Task Overview

This task provides the capability to convert L0R ingest reports from their native binary format and display the formatted results through a GUI display.

10.3.3.2 Initialization

This task is initialized by a selection of the corresponding menu item in the Analyst User Interface (AUI).

10.3.3.3 Normal Operation

After the task is invoked, it displays to the Analyst a file browser window. Using this window the Analyst selects an L0R ingest report to view. The task then opens and reads the binary file, formats its contents and displays it in a window to the Analyst. The Analyst exits the task by selecting the "Done" button on the file display window.

10.3.4 Perform Impulse Noise Analysis

10.3.4.1 Task Overview

This task provides the capability for the Analyst to perform bit flip classifications in support of the evaluation of Impulse Noise.

10.3.4.2 Initialization

This task is initialized by a selection of the corresponding menu item in the AUI.

10.3.4.3 Normal Operation

After the task is invoked, it displays an IDL window by which the Analyst can query the database and load arrays with flagged impulse noise occurrences. After loading the arrays, the Analyst can perform the bit flip classifications and save the results to the database for later trending.

10.3.5 Perform Coherent Noise Analysis

10.3.5.1 Task Overview

This task provides the capability for the Analyst to obtain, using the results of the Coherent Noise algorithm, estimates of the variance in the random noise for comparison with the results of the histogram analysis.

10.3.5.2 Initialization

This task is initialized by a selection of the corresponding menu item in the AUI.

10.3.5.3 Normal Operation

After the task is invoked, it displays an IDL window which will prompt the Analyst for input in order to retrieve the desired Legendre polynomial coefficients. After loading the data, the Analyst may then use the window functions to perform the desired analysis.

10.3.6 Perform Random Noise Analysis

10.3.6.1 Task Overview

This task provides the capability for the Analyst to convert detector level means and standard deviations to L and NEDL and plot them. Also, the task provides the capability to view output plots and reports generated by the Random Noise characterization.

10.3.6.2 Initialization

This task is initialized by a selection of the corresponding menu item in the AUI.

10.3.6.3 Normal Operation

After the task is invoked, it displays an IDL window which will prompt the Analyst for input in order to retrieve the desired Random Noise algorithm outputs. After loading the data, the Analyst may then use the window functions to perform the conversions and plotting as well as viewing of the other algorithm outputs.

10.3.7 Perform Gain-Fitting for the CRaM

10.3.7.1 Task Overview

This task provides the capability for the Analyst to perform gain-fitting on the results of the CRaM algorithm. It also provides the capability to examine correlation coefficients between the gain functions and analyze output degradation factors.

10.3.7.2 Initialization

This task is initialized by a selection of the corresponding menu item in the AUI.

10.3.7.3 Normal Operation

After the task is invoked, it displays an IDL window which will prompt the Analyst for input in order to retrieve the desired CRaM algorithm outputs. After loading the data, the Analyst may then use the window functions to perform the required gain fitting and analysis.

10.3.8 Perform Evaluation of the "Correct Coherent Noise" Algorithm

10.3.8.1 Task Overview

This task provides the capability for the Analyst to perform analysis on the residual coherent noise components in an image remaining after the application of the coherent noise corrections.

10.3.8.2 Initialization

This task is initialized by a selection of the corresponding menu item in the AUI.

10.3.8.3 Normal Operation

After the task is invoked, it displays an IDL window which will prompt the Analyst for input in order to retrieve the desired image to analyze. After loading the image, the Analyst may then use the window functions to select a subimage to analyze, perform the analysis, and write results to the database if required.

10.3.9 Perform Trending Analysis

10.3.9.1 Task Overview

This task provides the capability for the Analyst to perform trending analysis on the data contained in the trending database.

10.3.9.2 Initialization

This task is initialized by a selection of the corresponding menu item in the AUI.

10.3.9.3 Normal Operation

After the task is invoked, it displays an IDL window which will prompt the Analyst for input regarding the type of trending desired. The Analyst is presented, at the top of the initial dialogue window, with the trending type options “Radiometric,” “Geometric,” and “Ad Hoc.” Selection of one of these types causes further selection options based on algorithm to be presented on the dialogue window. After an algorithm option is selected and confirmed, a new analysis window is brought up to perform the appropriate trending analysis. For “Ad Hoc” analyses, no algorithm need be specified.

If trending of type “Radiometric” or “Geometric” is chosen, the Analyst is presented on the analysis window with a list of options for executing “canned” scripts appropriate for the chosen type and algorithm. If trending of type “Ad Hoc” is chosen, the user is presented with a list of parameters available for trending. In both cases, the user may specify filter parameters appropriate to the type of trending being performed. Once the trending script or parameters are specified together with any filter parameters, the user submits the request, the application retrieves the data and produces the plot. The user may also inspect the numerical values of the data and also save the plot to a file for later incorporation into reports. In some cases, a limited function-fitting capability is available. The user may superimpose plots and overplot spec values. Also, basic statistics of the plotted data are calculated and made available for inspection.

Section 11. Database Design

11.1 Introduction

The IAS database provides the communication between the subsystems for Work Order creation, processing, status, trending data, operational support, user interface, etc. for the IAS system.

During the preliminary design phase, a logical database design was established to incorporate the functional data requirements and the interface between the database and the IAS subsystems. During the detailed design phase, the logical design was converted to a physical design.

11.2 Logical Design

The goal of logical design is to provide an accurate model of the information needs of the organization. This model is diagrammed in an entity relationship diagram (ERD), which expresses the data model in terms of entities, relationships, and attributes. The ERD also provides a model which is independent of any particular data storage and access method and allows objective decisions to be made about implementation techniques and coexistence with existing systems. The logical design is independent of any particular physical implementation but is used to establish the physical database design.

Entity Relationship Modeling involves identifying the items of importance in an organization (entities), the properties of those items (attributes), and how they are related to one another (relationships). The IAS Entity Relationship Model is expressed conceptually as an ERD (Figure 11-1). These items are described in more detail in the following paragraphs.

11.2.1 Entities

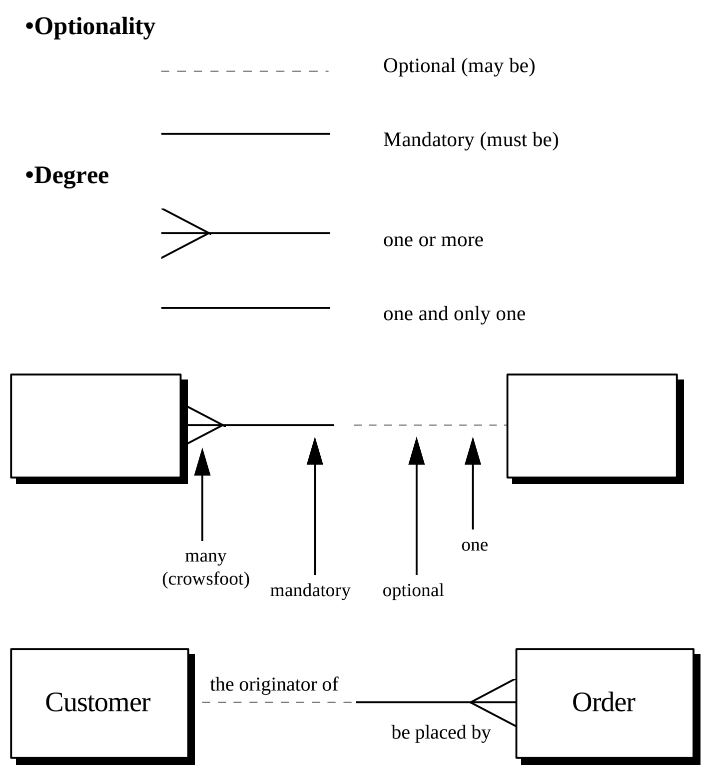
Entities represent data items that play a functional role in the IAS application and have their own set of attributes. An entity is a thing or object of significance about which information needs to be known or held. Each entity is expressed on the ERD as a box. The name of the entity is in bold followed by names of the attributes associated with the entity. Table 11-1 provides a description of each entity.

11.2.2 Attributes

Attributes are details that serve to either express the state of, qualify, identify, classify, or quantify an entity. Each attribute on the ERD is defined as either a primary key (#) attribute, a mandatory (*) attribute, or an optional (o) attribute. Primary keys are used to uniquely define an occurrence of the entity. Mandatory attributes require a data value at all times; optional attributes may be left null.

11.2.3 Relations

A relation is a significant association between two entities that is given a name. Relationships represent the association between the occurrences of one or more entities that are of interest to the IAS. There is a cardinality associated with each relationship. The cardinality describes the number of occurrences of one entity that can be associated with each occurrence of the related entity. Relationships on the ERD is expressed using the following symbols.



For example;

Each **Customer** may be the originator of one or more **Order**.
Each **Order** must be placed by one and only one **Customer**.

REVIEW

TBS

Figure 11-1 IAS ERD

TBS

Table 11-1 Entities and their Descriptions (Page 1 0f 8)

TBS

Table 11-1 Entities and their Descriptions (Page 2 0f 8)

REVIEW

TBS

Table 11-1 Entities and their Descriptions (Page 3 0f 8)

REVIEW

TBS

Table 11-1 Entities and their Descriptions (Page 4 0f 8)

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Table 11-1 Entities and their Descriptions (Page 5 0f 8)

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Table 11-1 Entities and their Descriptions (Page 6 0f 8)

TBS

Table 11-1 Entities and their Descriptions (Page 7 0f 8)

REVIEW

TBS

Table 11-1 Entities and their Descriptions (Page 8 0f 8)

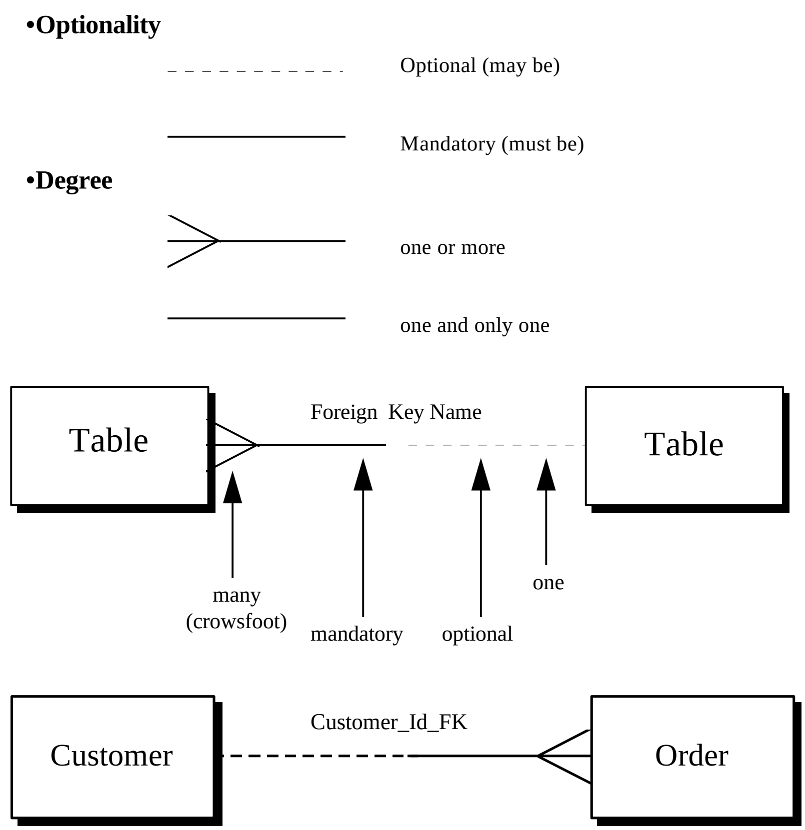
11.3 Physical Design

REVIEW

The physical design of the database is the result of converting the logical data design into a design that can be supported by the type of DBMS selected. Physical database design has several objectives:

- To optimize the logical schema as necessary while preserving the consistency and flexibility of data
- To determine the data storage requirements
- To determine data integrity and security rules
- To optimize the usage of the DBMS capabilities

The physical model of the design is depicted using a schema diagram (Figure 11-2) very similar to the ERD. The schema diagram represents: tables, elements, indexes, integrity constraints, views and snapshots. Tables and foreign keys on the schema diagram are expressed using the following symbols.



For example:

Each **Customer** record must have a unique Customer_Id.
Each **Order** record would be validated against the **Customer** table using the foreign key Customer_Id_FK.

REVIEW

TBS

Figure 11-2 IAS Schema Diagram

REVIEW

11.3.1 Tables

The tables and columns compose the basic physical database design units. A database table is a basic unit of storage. Actual data is stored in rows according to a predefined table schema. Entities and relationships become tables and attributes become table columns. A full description of each table and its associated columns are described in the database table definition report (Appendix D).

11.3.2 Indexes

As part of the physical design analysis, indexes were determined for the tables. Indexes must be chosen carefully because they require maintenance as records are added and deleted from the tables and because they require additional extra storage space. Indexes can, however, significantly reduce the data retrieval time. Thus, indexes are crucial for performance. Indexes can also be used to ensure that data column or combination of columns are always unique within a given table.

11.3.3 Integrity Constraints

Integrity constraints provide a means of ensuring that changes made to the database do not result in a loss of data consistency. Thus, integrity constraints guard against accidental damage to the database. The following types of integrity constraints were considered in the design and described in the database table definition report (Appendix D).

- Domain Rules - Define a set of legal values (called domain rules) for a column or set of columns and instruct the DBMS to check all values that users try to store and to reject any that are illegal.
- Unique Keys - Prevent storing more than one record having duplicate values in a specified column or set of columns in a table. This is achieved by defining an implicit unique index on each set of columns by the DMBS. The DBMS will reject any attempt to store duplicate values that should be unique.
- Primary Keys - Prevent storing more than one record having duplicate values in a specified or set of columns in a table. It also disallows null values entering in the specified columns. This constraint is enforced by the implicit creation of a unique index on that column and a not null constraint on that column by the DBMS.
- Foreign Keys (referential constraints) - Whenever a primary or alternate key values from one table are stored as a foreign key in another table, it must be insured that the reference should be valid. To preserve referential integrity, checking should be performed each time a record of a table containing foreign keys in inserted. The DBMS should check that the new foreign key values exist in another table and should not allow the insertion or update if they do not

exist. Also, the DBMS perform a check every time a record or a table is deleted or modified because records of other tables may exist that point to that table row using foreign keys.

- Null - A rule defined on a single column that allows or disallows inserts or updates of rows containing a null for the column.

11.3.4 Database Storage Requirements

During the detailed design phase, the rows for each table are defined along with their minimum and maximum sizes. Using assumptions from the application, the total number of rows for each table is estimated. These estimations are fed into formulas to calculate the starting and maximum size of each table and the size of its associated primary key. Tables and indexes allocated to tablespaces and tablespaces are combined to estimate the total database size for the application. The IAS database is divided into three tablespace for data:

- Static Data - Tables allocated to this table space seldom changes. Nominal statistics, system parameters, directives, etc. are examples of tables allocated to this tablespace.
- Dynamic Data - Tables allocated to this tablespace change often during processing. These tables support ingest, work order definition, processing parameters, control, etc.
- Trending Data - Data in this tablespace holds the trending output form IAS. Trending data received from LPGS will also be stored within this same tablespace.

For the static data, the number of rows is relative constant. The storage needed for the static data tables is the sum of each table’s row length times the number of rows in the tables. The row length includes DBMS overhead for each column and row in the tables. In addition, the DBMS organizes the data into blocks requiring additional table overhead. For the dynamic and trending data tables, the storage is calculated based on the maximum number of rows expected at a time. A further detailed description of the formulas used for the sizing estimates is provided in Appendix F.

11.4 IAS Database Sizing

This section presents the assumptions for database sizing, estimates on table sizing and, estimated database size.

Table 11-2 lists the assumptions were used in calculating the size of the database. Table 11-3 lists the table sizes and row estimates. Table 11-4 provides the details of the results calculated for the database tables and rows over the life of the system.

Table 11-2. IAS Database Sizing Assumptions

Procedures/Programs	
1	Procedures/Work Order
24	Procedures
36	Scripts
24	Programs
1.5	Programs/Script
7	Scripts/Procedure
6	Parameters/Program
Scenes	
10	Scenes/Day
1	Work Orders/Scene
1	Scenes/Work Order
9	Bands/Scene
1	L0R Products/Scene
6	Major frames/Scene
1.11	Calibration Source/Scene
375	Scans/Band
Trending	
4	Regions of interest/Detector/Scan
2	Scan Directions
2	SCS Levels
3	Segments/Detector/Scan
375	Scan lines/Detector/Scene
6600	Pixels/Detector/Scan
0.0000001	Pixel of interest/Detector/Scan
16	Detectors/Band
	Number of Scenes used for
2	Band to Band/Month
2	Band alingment/Month
1	Image to Image/Month
2	Geodetic/Week
1	Geometric/Month
1	Mirror/Month
2	Sensor Alignment/Week

Calibration	
365	PASC/Year
8	FASC/Year
20	GLC/Year
0.5	Probability of Specifying Gain
1	Gain/Band
Duration	
20	Workdays/Month
12	Months/Year
5	Years
4	Quarters/Year
Miscellaneous	
8	File Types
1.5	Default Directory/File
1	L1RG Products/Work Order
2	Events/Program execution
0.5	Orbit Based Request/CSR
0.5	WRS Based Request/CSR
4	Calibration Parameter Files generated/Year
12	Quarterly Reports
3	Monthly Reports
Ephemeris	
1	Ephemeris Request/month
2	Types of ephemeris each received once/month

Table 11-3. Table Size and Row Estimates

-- *Note: The following sizing estimates for trending data include Geometry trending data only and does not include Radiometry. New sizing estimates will be generated after the final
trending attributes have been incorporated into the design.*

Table Name	Table Space	Number of Rows	Row Size Bytes	Total Size
Geometric_Stats	Trend_Data	60	260	20.48 K
I2I_Stats	Trend_Data	60	190	14.34 K
Mirror_Stats	Trend_Data	60	311	46.91 K
Geodetic_Stats	Trend_Data	520	183	118.78 K
S_Align_Stats	Trend_Data	520	259	178.18 M
B_Align_Stats	Trend_Data	3,360	111	458.75 M
Scene	Trend_Data	12,000	568	2.46 M
Proc_Scene	Trend_Data	12,000	124	1.76 M
PCD_Major_Frame	Trend_Data	72,000	189	16.38 M
Scan_Group	Trend_Data	216,000	33	8.19 M
Band	Trend_Data	324,000	50	20.11 M
Pixel	Trend_Data	427,680	43	22.46 M
Facet_Aggregates	Trend_Data	432,000	35	18.83 M
Detector	Trend_Data	1,728,000	34	72.22 M
Det_Aggregates	Trend_Data	3,456,000	36	153.87 M
Facets	Trend_Data	6,912,000	37	314.57 M
Segment	Trend_Data	10,368,000	39	493.81 M
Scan	Trend_Data	40,050,000	40	1.97 G
Region	Trend_Data	259,200,000	41	12.95 G
Scan_Line	Trend_Data	648,000,000	39	30.86 G
Nominal_L0R_stats	Static_Data	1	112	4.1 K
Sys_Parms	Static_Data	1	44	4.1 K
Foreign_Host	Static_Data	10	145	4.1 K
Def_Directory	Static_Data	24	89	4.1 K
Module	Static_Data	100	29	4.1 K
Message	Static_Data	250	95	28.67 K
Sub_Module	Static_Data	300	38	14.34 K
Def_Parm	Static_Data	1,500	89	161.79 K
CPF_Catalog	Dynamic_Data	40	38	4.1 K
Ephem_Requests	Dynamic_Data	60	62	6.14 K
Ephem_Files	Dynamic_Data	120	41	6.14 K
CSR_Orbits	Dynamic_Data	982	35	43.01 K
CSR_WSR	Dynamic_Data	982	67	81.92 K
IPC_Directive	Dynamic_Data	1,000	99	120.83 K
Cal_Scene_Request	Dynamic_Data	1,965	56	135.17 K
File_Transfer	Dynamic_Data	2,465	281	841.73 K
CSR_Gains	Dynamic_Data	8,842	30	329.73 K
L0R_Data_Datalog	Dynamic_Data	12,000	243	3.51 M
L1R_Data_Catalog	Dynamic_Data	12,000	193	2.73 M
Work_Order	Dynamic_Data	12,000	363	6.14 M
Event	Dynamic_Data	37,800	144	6.45 M
WO_Script	Dynamic_Data	252,000	46	14.34 M
WO_Param	Dynamic_Data	2,268,000	86	232.24 M

Table 11-4. Estimated Database Size Summary

Note: The following sizing estimates for trending data include Geometry trending data only and does not include Radiometry. New sizing estimates will be generated after the final trending attributes have been incorporated into the design.

Initial Size : 821.25 Kb End Size : 102.70 Gb Max. Size : 102.70 Gb

Blocksize : 2048

No. Tablespaces : 6 No tables : 44 No keys : 70

Space needed for Tables :

Tablespace	Initial	End Size	Max. Size
Static-Data	206.85 Kb	225.28 Kb	225.28 Kb
Dynamic-Data	61.44 Kb	258.71 Kb	266.99 Kb
Trending	86.02 Kb	46.91 Gb	46.91 Gb
Total	**354.30 Kb**	**47.16 Gb**	**47.17 Gb**

Space needed for Indexes :

Tablespace	Initial	End Size	Max. Size
Static-Data	212.99 Kb	239.62Kb	239.62 Kb
Dynamic-Data	118.78 Kb	490.25 Kb	490.23 Kb
Trending	135.17 Kb	55.05 Gb	55.05 Gb
Total	**466.94 Kb**	**55.54 Gb**	**55.54 Gb**

11.5 Database Administration

This section briefly describes database administration procedures to facilitate data security, integrity, backup, and recovery. A detailed description of the steps procedures will be described in the IAS database administration manual.

11.5.1 Security

REVIEW

Database security will be accomplished at two levels, system security and data security, utilizing ORACLE provided security features to control IAS database accessibility and usage.

System security includes the mechanisms that control the access and use of the database at the system level. The database system security options include:

- valid user name/password combination
- authorization to connect to the database
- the amount of disk space available to the objects of a user/process
- the resource limits for a user/process
- audit of designated limits for a user/process
- which system operations a user group can perform

Data security includes the mechanisms that control the access and use of the database at the object level. The database data sevurity options include:

- which users have access to a specific schema object and the specific types of actions allowed for each user on the object (e.g. user A can issue SELECT and INSERT statement but not DELETE statements using the B table)
- the actions, if any, that are stored in the LPS data dictionary

12.5.2 Backup

ORACLE provides the capability to perform both full and partial backups of the database. A full backup is defined as including all tables and files associated with the IAS database system. The database must be closed and off-line to perform a full backup, and thus this should be a scheduled activity.

A partial backup, sometime referred to as an incremental backup, can occur while the database is on-line and active. Only specific data is processed in the backup. This activity permits the storage of selected database tables, while not impacting the current operations. This procedure should enhance but not replace scheduled full backups.

12.5.3 Recovery

Recovery after a crash (power failure) is automatically handled by ORACLE as part of the normal database startup procedure. All transactions committed before the system crash are recovered and the uncommitted transactions are rolled back.

In the event of a media failure (a disk crash or corruption), the data on that device can be restored from a backup copy. The data will be restored to the time of the backup (ORACLE Export utility can be used); data modifications that were applied after the backup will be reapplied if the log files are available.

Section 12. User Interface

12.1 Introduction

The IAS provides two user interfaces, the Operations User Interface (OUI) and the Analyst User Interface (AUI). This section describes both interfaces.

The OUI is the primary interface between the operator and the IAS subsystems (excluding the Evaluation and Analysis subsystem). The operator provides support to the analyst by scheduling WOs, obtaining the L0R for the WOs and monitoring the operations of the IAS. The interface uses Web Browser software, ORACLE's SQL*Forms (using Motif-style X-windows) to provide the operator with a menu driven user interface.

The AUI is the primary interface between the analyst and the IAS subsystems. The analysts perform assessments on completed WO and update the CPF based on trending data produced from analyzed WOs. The interface uses ENVI and IDL running under X windows to provide the analyst with a menu-driven window environment for evaluation and assessment functions.

12.1.1 Design Considerations

The OUI uses a set of standalone applications that are compatible but loosely integrated. For instance, the operator uses the cut and paste operations to move data between the Web Browser and Oracle Forms GUI displays.

The AUI uses ENVI and IDL running under X windows provides menu access to built-in ENVI and IDL functions. In addition, ENVI and IDL also provide access to custom IDL applications and other COTS software needed for evaluation and assessment.

The screens in the OUI and AUI will employ the same look and feel to minimize unique operations.

12.1.1.1 Assumptions and Open Issues

The following are the design assumptions for the IAS user interfaces:

- OUI and AUI run on the SGI
- AUI runs on an Analyst workstation
- One person may execute both the OUI and AUI

- The account running the interface is internally captured and has no external user interface

12.1.2 Development Tools

To design and develop the IAS user interfaces, the developers used different design tools to provide different capabilities. These tools are the Oracle Corporation Development Environment (CDE) tools, ENVI, and IDL. The following subsections describe the tools used to develop specific OUI or AUI.

12.1.2.1 Oracle Corporation Development Environment (CDE) Tools

Oracle CDE tools are used for designing the OUI. CDE tools are built on top of a layer called the Oracle Toolkit. The Oracle Toolkit makes it possible to create applications that run against multiple user interfaces, such as Motif or MS Windows, while retaining the full native look and feel of the interface. Oracle Menu and Oracle Forms of the CDE tools are used to build the IAS interface.

12.1.2.1.1 Oracle Menu

Oracle Menu is a screens-based applications development tool that provides a single menu interface for running multiple data-processing tools.

12.1.2.1.2 Oracle Forms

Oracle Forms is a screens-based application development tool for quickly building interactive applications that access Oracle 7 data.

12.1.2.2 Environment for Visualizing Images (ENVI)

The ENVI software package is used for designing and implementing the AUI. ENVI is a software package designed for analyzing all types of remote sensing data, including panchromatic, multispectral, and hyperspectral imagery. ENVI, written in IDL, provides an extensive and extensible menu-driven GUI and includes a base set of menus to access its image analysis functions.

12.1.2.3 Interactive Data Language (IDL)

The IDL software package is used for designing and implementing the AUI. IDL provides the developer the ability to customize and extend the base set of ENVI menus to provide access to additional IDL applications as well as to other COTS software.

The IDL software package provides a complete computing environment for the analysis and visualization of data. IDL offers a set of widgets that allow the creation of complete GUIs. IDL also includes the Widget Builder, a graphical interface design tool.

12.2 Interface Tasks

This subsection identifies the primary operations and analyst tasks supported by the User Interface and provides a brief description of each task.

12.2.1 Operations Tasks

The primary tasks of the IAS operator are as follows:

- Order data from DAAC
- Setup/modify WO
- Monitor status of WOs
- View system messages and alerts
- Query database
- Generate MOC requests
- Generate Calibration Parameter File
- Transfer files
- Generate DAAC transfer requests
- Startup/Shutdown the IAS software

12.2.1.1 Order Data from DAAC

To order data from the DAAC, the operator uses a Web Browser to connect to the DAAC Web server and then browses the DAAC for available data files. Metadata attributes are used to search for a particular data file or a set of files meeting a specified set of parameters. After locating the data files, the operator updates the appropriate WO with the id of the L0R data file, or creates new work orders with the id of the L0R data file known.

12.2.1.2 Setup/Modify WO

Using the WO Setup and Control screen, the user defines the work to be performed on the identified L0R data or to modify existing WOs. The screen allows the user to select from a list of defined procedures that specify the work processing and the input parameters to use. Other control parameters such as processing priority, date processing completion is required, etc. may also be specified. The screen allows the user to resume a paused WO and to restart WO processing in the event of a failure.

12.2.1.3 Monitor Status of WO

At the completion of each job processing step, IAS updates the status of the WOs. Using the Display WO Status screen, the user obtains a display that shows the current status of a WOs. The user controls the contents of the display by selecting options on the work order filter screen, i.e. work order start date, work order state.

12.2.1.4 View Messages and Alerts

During the processing of each WO, IAS logs messages for critical events. Using the Monitor Events screen, the user obtains a display that shows the logged messages.

12.2.1.5 Query Database

The operator uses pre-defined or ad hoc queries to obtain data from the IAS database. To obtain a report of the requested data, the user identifies a file to receive the data.

12.2.1.6 Generate MOC Requests

Using the Request Files menu option, the user selects either a PAC, FAC, GLC or concentrated ephemeris. The appropriate screen then allows the user to enter the data required to cause the generation of MOC requests and to stage the requests for transfer. IAS generates the correctly formatted requests for calibration images and concentrated ephemeris files using the entered data. The request files are send to the appropriate location via the DDM task. Th*e Landsat 7 Mission Operations Center (MOC) to Image Assessment System (IAS) Interface Control Document (ICD)* specifies the format for these requests.

12.2.1.7 Send MOC Requests

Using the Request Files menu option, the user will have selected either a PAC, FAC, GLC or concentrated ephemeris. One option on each of these screens is Destination. The user presses this button and sees a screen on which to enter the destination data. When the user presses "OK" on the main window, the file will be marked in the database as "ready to send" and the DDM task will poll and send the file to the appropriate destination.

12.2.1.8 Generate Calibration Parameter File

The IAS generates a CPF used in the processing of Landsat-7 data at least one every 90 days and distributes it to those facilities that requested it. Using the Calibration Parameter File - Generate screen, the user initiates the production of the CPF. The user enters input parameters that control the data from the IAS database used in the production of the CPF. After the creation of the CPF, it is reviewed and approved for release before being moved to the staging area for transfer, using the Calibration Parameter - Send screen.

12.2.1.9 Send Calibration Parameter File

Using Calibration Parameter - Send screen, the file is staged to a directory for the DAAC to retrieve. Using the Web Browser to connect to the DAAC Web Server, the user generates a request for the DAAC to transfer the specified file from the IAS. The DAAC performs a ftp get to pull the CPF from the IAS staging directory. The IAS database is updated to indicate that the file was "sent." If the calibration parameter file is sent to the MOC, a value is set in the database for the DDM task. This task then ftps the file to the
designated location.

12.2.1.10 Monitor L0R Products

Using the Monitor L0R Products screen, the user may see the products that have arrived in the IAS system and have been entered into the database. This screen merely shows all L0R products that have been cataloged and nothing on this screen may be modified. (They are ordered by most recent receipt time at the top.)

12.2.1.11 Monitor Transfers

Using the Monitor Transfers screen, the user may specify whether to view ftp transfers, or transfers to tape. The user may only modify the number of times a products has attempted to be transferred (for ftp products) on this screen.

12.2.1.12 Shutdown IAS Software

Using the Shutdown screen, the operator causes the system to shutdown. The shutdown option halts the submission of new WOs but allows current WOs to complete processing if the “graceful” option is selected. The operator can cause current WOs to suspend processing at the end of the currently executing script by using the WO Setup and Control screen to set the appropriate control parameter. To abort all tasks, the user selects the “immediate” option.

12.2.2 Analyst Tasks

The primary tasks of the IAS Analyst are as follows:

- Display IAS Data
- Edit IAS Data
- Analyze IAS Data
- Generate Reports
- Submit Jobs

12.2.2.1 Display IAS Data

The Display IAS Data function provides the user with a variety of tools for displaying the inputs to and the results of Level 1 or Calibration processing. Included are capabilities for ASCII file display, formatted binary file display, and graphical image display.

12.2.2.2 Edit IAS Data

The Edit IAS Data function allows the user to modify any file input to a WO for the purpose of performing “what if” analyses. Files that may be edited include image files, PCD, MSCD, Calibration Parameter File, GCP residuals, and others.

12.2.2.3 Analyze IAS Data

The Analyze IAS Data function provides statistical analysis, trending, and image manipulation capabilities. These functions are used to conduct a more analytical evaluation of processing inputs and outputs, to summarize large volumes of data, and to support the Analyst in visualizing trends and problems.

12.2.2.4 Generate Reports

The Generate Reports function is used to generate monthly, quarterly, and annual formatted reports summarizing ETM+ instrument and IAS system performance for output to the MMO and other external recipients. The function provides for formatted text entry as well as the ability to incorporate graphics generated by data analysis packages.

12.2.2.5 Submit Jobs

The IAS Analyst uses the Submit Jobs function to execute stand-alone Radiometry or Geometric Processing Subsystem applications or to submit WOs for execution.

12.3 Operations User Interface Architecture

Primarily, the OUI for IAS is a graphics-based application to operate the IAS and to monitor its status. The graphics interface, developed using Oracle Forms, provides access to functions by selection of menu items. All logic for retrieving information and controlling user's input with this graphics interface is incorporated into the designed system using Oracle Forms triggers. Third generation language (3GL) routines, such as C subroutines (user exits), are invoked from triggers to perform file I/O and system service calls. The user runs the graphics interface through the Oracle Forms "runform" function.

In addition, standalone applications that are compatible but loosely integrated supplement the OUI interface. For example, the operator uses the standalone cut and paste operations to move data from the Web Browser and Oracle Forms or other GUI displays.

The following subsections present the graphics-based architecture for the operations user interface.

12.3.1 Menus and Controls

Upon initiation of the OUI, the main window is displayed. This window contains a series of pull down menus that allow the user to invoke various functions of the interface. Menu items are selected (i.e., invoked) with the mouse by placing the cursor on the name of the desired menu, pressing the left mouse button, moving the cursor to the desired item (with the button still down), and releasing the button.

REVIEW

There are seven major functions for an operator.

- System Functions
- Work Order Functions
- Data Acquisition Request Functions
- Calibration Parameter File Generation Function
- Monitoring Function
- Data Ordering Function

The following subsections define the OUI menus with their submenus items.

12.3.2 SYSTEM Menu Item

The SYSTEM Menu has seven submenu items:

- Copy to Tape
- Create New Procedure
- Configure
- Start IAS
- Restart
- Shutdown IAS
- Close

The following subsections describe the available items under the System Menu.

12.3.2.1 Copy to Tape

Select the "COPY TO TAPE" item in the System menu to activate the Oracle form - Copy to Tape. This screen displays a list of what is ready to be written to. The file names and directory are listed in the database. The listed files are already in the tar format and only are for work orders that have been marked as completed. The operator enters a volume label for the tape and the tar file to be copied.

The user will then select OK to write the tar file(s) to tape or CANCEL to take no action. The data is recorded in the database to be displayed on the Monitor - Transfers screen.

12.3.2.2 Create New Procedure

Select the "CREATE NEW PROCEDURE" item in the System Menu to Activate the Oracle form - Create New Procedure. This screen provides the user with the ability to select scripts and set the sequence number of the script for a new procedure.

12.3.2.3 Configure

Select the "CONFIGURE" item in the System menu to activate the Oracle form - Configure . This screen provides a list of IAS configuration parameters. The user can modify the parameters. The parameters are:

- First advisory limit for disk
- Second advisory limit for disk
- Maximum number of concurrent work orders
- work order scheduler interval
- deletion interval
- check disk interval
- PSI polling interval

When the cursor appears over an entry, useful hints describe the parameter. The user selects OK or CANCEL to apply all the changed values or let them remain as they are for the configuration. Changing these parameters will not critically affect the operation of the system.

12.3.2.4 Start IAS

Select the "START IAS" item in the System menu to activate the Oracle form - Start IAS. This screen shows a reminder to set the configuration parameters if they have not been set to the desired values. The user selects OK to start the IAS. A script is executed to start the PSI (Startup IAS) task that starts the other kernel tasks.

12.3.2.5 Restart

Select the "RESTART" item in the System menu to activate the Oracle form - Restart. This screen lists the background tasks and allows the user to restart one or more of the tasks, even if they are currently working. If the task is currently running and is to be restarted, it will first be killed and then restarted at the user's request. The tasks for selection are

- PWS (WO scheduler
- DIM (MOC Ingest)
- DRM (Resource Manager)
- DDM (Data Manage)

However, the status of the task is not shown. It is up to the user to determine if a task is running or not before selected it to be restarted. Pressing the OK button notifies the PSI task, through the database, to restart the indicated tasks.

12.3.2.6 Shutdown IAS

Select the “SHUTDOWN IAS” item in the System menu to activate the Oracle form - Shutdown IAS. This screen allows the user to select whether to gracefully shut down the system or to terminate (abort) all tasks. If graceful is selected, and the user clicks OK, active tasks will run to completion before terminating. Therefore, shutdown is not immediate or abrupt. If immediate is selected, tasks will be aborted. The PSI task is notified that a shutdown is requested by setting a request flag in the database.

12.3.2.7 Close

Select the “CLOSE” item in the System menu to deactivate an Oracle form that is currently the active window. Note that multiple windows may be part of an Oracle form. If this is true, all windows will be shut down using the close option. Since a form only has one message line, the user knows whether or not the form has multiple windows by looking for a message line on each window.

12.3.3 WORK ORDER Menu Item

The WORK ORDER Menu has eight submenu items:

- Create New
- Create from Template
- Create Series of WOs
- Modify a WO
- Delete WO
- Continue WO Processing
- Abort WO Processing
- Mark WO as Completed
- WO Status

The following subsections describe the available items under the Work Order Menu.

12.3.3.1 Create New

Select the “CREATE NEW” item in the Work Order menu to activate the Oracle form - Create New. This screen displays an empty window with just the fields of the WO. The user enters all values desired and clicks OK to create the WO. The following identifies the displayed fields including the fields that the user optionally enters:

- Requester Name (Display Only)
- Current Time: (Display Only)
- Request Type (Standard, Test, Custom)
- Processing priority (High, Medium, Low -- Default = Medium, only privilege user will be allowed to enter High)
- Directory for WO files
- Requested Start Time (Format: DD-MON-YY HH-MI-SS -- Default modifiable current time)
- Requested Completion Time (Optional -- Format DD-MON-YY HH-MI-SS -- Default: Blank)
- L0R product id
- Calibraion Parameter File: (Optional)
- Procedure name
- Ephem type (PCD, Concentrated, Definitive)
- Pushbutton to Modify/ Browse Parameters
- SUBMIT and CANCEL pushbuttons

If the field, Directory for WO files, is left blank, PCS creates a directory. If not, IAS verifies the existence of the entered directory and verifies that the entered directory has read and write permissions. When the user presses the SUBMIT button, a popup window displays the assigned WO ID for the created WO.

12.3.3.2 Create From Template

Select the “CREATE FROM TEMPLATE” item in the Work Order menu to activate the Oracle form - Create from Template. This screen displays an empty window with just the blank fields of a WO. After the user enters a WO ID, the values from the identified WO are displayed with the directory field blank. The user modifies any of the fields, then clicks on OK to create a new WO. When the user clicks OK, a popup window displays the WO ID assigned to the created WO.

12.3.3.3 Create Series of WOs

Select the “CREATE SERIES OF WOs” item in the Work Order menu to activate the Oracle form - Create Series of WOs. This screen is used to create routine WOs. The user is prompted to enter the WO ID that is the template, the number of WOs to create, and the time interval between the WOs. All these WOs are inserted into the WORK_ORDERS table with blank L0R product Ids when the user selects OK. The Update Product Id menu option is used to enter the DAAC retrieved L0R product Id to the WOs when this series of WOs is needed for processing. After the user clicks OK, a popup window displays a range of WO IDs assigned to the created series of WOs.

12.3.3.4 Modify a WO

Select the "Modify WO" item in the Work Order menu to activate the Oracle form - Modify WO. This screen prompts the user for a WO ID and the values for the identified WO are displayed. The user can modify any work order parameter e.g. L0R product id. The user may not use this screen to modify a WO that has already started running.

12.3.3.5 Delete WO

Select the "DELETE WO" item in the Work Order menu to activate Oracle form - Delete WO. This screen prompts the user for the WO ID that needs deletion. Only WOs that are not completed and whose request type is "Std" can be deleted. A confirmation dialog will be displayed to get the confirmation for the deletion. After confirmation, the WO is physically deleted from the WORK_ORDERS table.

12.3.3.6 Continue WO Processing

Select the "CONTINUE WO PROCESSING" item in the Work Order Menu to activate the Oracle form - Continue WO Processing. This screen prompts the user to enter the WO ID to be continued. Only WOs in the "Halted" state can be continued. If the WO is in the "Halted" state, the state is changed to "In Progress." The PWC task resumes the processing of the WO at this time.

12.3.3.7 Abort WO Processing

Select the "ABORT WO PROCESSING" item in the Work Order Menu to activate the Oracle form - Abort WO Processing. This screen prompts the user to enter a WO ID to be aborted. Only the WOs in the "Halted" state can be aborted. If the WO is in the "Halted" state, the selected WO is aborted.

12.3.3.8 Mark WO as Completed

Select the "MARK WO AS ANALYZED" item in the Work Order Menu to activate the Oracle form -- Mark WO as Analyzed. This screen prompts the user for the WO ID to be marked as analyzed. Only WOs with a state of "In Assessment" can be marked as analyzed. The GUI changes the WO state from "In Assessment" to "Completed."

12.3.3.9 WO Status

Select the "WO STATUS" item in the Work Order menu to activate the Oracle form - WO Status.

- <u>Short Status of all the Work Orders</u>. This screen updates every xx seconds shown as refresh rate on the screen. This status screen displays the WO ID, procedure name, priority, L0R product id, WO state, and active script id. There will be control buttons to Get Details.., Get Scripts status, filter, and cancel. The first two buttons apply to the selected WO.

  When the "Get Detail.." button is pressed, the detailed status screen (described below) for the selected WO is displayed.

  When the "Script Detail.." button is pressed, the progress of the WO at script level is displayed.

  When the "Filter" button is pressed, a display prompts for entry for time range, product id, and WO state. After entry the appropriate filtered data are displayed.

  Default display shows xx WOs with start time = current time - xx days.

  To jump back/forward in the work order processing, script state on theScript Status screen can be modified.

  Example:

Work Order Script Status screen	
script_1	Completed
script_2	Completed
script_3	Halted (Completed with a Pause Flag set)
script_4	Idle
script_5	Idle

  1: To jump to script_1
  The operator changes script_1 to Idle, Clicks on OK button.
  This takes you back to the Short Status of All Work Orders screen.
  Click on "Continue" button to continue the WO from script_1

  Change the state of script_2 and script_3 to "Idle." The PCW task resumes the WO from script_1

2: To skip over script_4, the operator changes script_4 state to “User Skipped”, clicks on “Continue” button to continue WO.
The PCW resumes WO processing by starting script_5.

!!!!!!!!! CAUTION !!!!!!!
!!! When jumping scripts, the user is cautioned that the original information for
!!! the setting up the WO will be altered in the database and cannot be retrieved
!!! at a future date. The user may also change the parameters for a script or
!!! programs when using the jump option
!!!!!!!!! CAUTION !!!!!!!

- Detailed Status of a Work Order. The following fields will be displayed on the detailed status screen:

  - Work Order Id
  - Requester
  - Priority
  - Request type
  - Start Time
  - Work Order directory
  - Requested completion date
  - Actual completion data
  - Ephem file name/type
  - WO comment
  - Status

12.3.4 REQ FILE Menu Item

The REQ FILE Menu has four submenu items:

- PAC
- FAC
- GLC
- Conc Ephem

The following subsections describe the available items under the Req File Menu.

12.3.4.1 PAC

Select the "PAC" item in the Req File menu to activate the Oracle form - PAC. This screen displays the fields to be populated to generate the calibration scene request file by orbit number. The first three fields displayed on this screen are populated by the system
and may not be modified by the users. The user populates the other fields. The following are the displayed fields:

- File Prefix — file name without the version number extension
- Version Number — the version number that is the extension for the filename
- Request Type — PAC

- Calibration Lamp — (on/off)
- Lamp Sequence Mode — (0 - 5)
- Orbit Number — (00000-99999)
- Start Angle — (imaging begins when sun reaches this angle: +/-xx.xx)
- End Angle — (imaging completes when sun reaches this angle: +/-xx.xx)
- Gain — (all blanks -- default, or a combination of H and L; the gain for each band -- default will be all blanks in the request file; user specified will be a 9-character field concatenating H or L for each band); is a pushbutton that brings up a separate window
- Destination — (pulldown will display host name from the foreign_host table and user will select one); this is a pushbutton that brings up a separate window

After the user clicks on the OK button, the screen updates the database with the above information, including name of file. The filename will follow the ICD naming conventions. The ASCII file will be built, putting "TEXTEND;" at the end of the file to complete the format of the request file. It will send the request file to the specified location (staging directory listed in the def_directory table) by updating the status field in the database to "ready-to-send" after the ASCII file is created. The DDM task continuously polls and notifies the DFT task when it detects the readiness of the file. The DFT task uses the ftp "put" to send the file.

12.3.4.2 FAC

Select the "FAC" item in the Req File menu to activate the Oracle form - FAC. This will be identical in form and function to the FAC except the field "request type" is set to "FAC."

12.3.4.3 GLC

Select the "GLC" item in the Req File menu to activate the Oracle form - GLC. This screen displays the fields required to generate the calibration scene request file by WRS path and the row. The system populates the first three fields displayed on this screen. The user cannot modify these fields. The user populates the other fields. The following are the displayed fields:

- File Prefix — file name without the version number extension
- Version Number — the version number that is the extension for the filename
- Request type — GLC

- Start path — (001 - 233)
- Start row — (001 - 248)
- Number of rows — (01 - 75)
- Acquisition date(s) — (mm/dd/yyyy,mm/dd/yyyy)
  -- One date indicates when to schedule the request
  -- two dates, separated by a comma indicates a period of time for the acquisition
- Periodicity/minimum number of acceptable days
- Minimum expected sun angle — (00 - 70 or Blank for any)
- Maximum expected sun angle — (00 - 90 or Blank for any)
- Maximum predicted cloud cover threshold
- Calibration Lamp — (on/off)
- Sequencing of lamp states — (0 - 5)
- Number of imaging instances — (00 - 99)
- Gain each — (all blanks or a combination of H and L -- the gain for band -- default will be all blanks in the request file; user specified will be a 9-character field concatenating H or L for each band)
- Destination — (pulldown will display host name from the foreign_host table and user will select one)

The user clicks on OK and the screen updates the database with the above information, including the filename, and builds the ASCII file, putting "TEXTEND;" to complete the format of the request file. After the creation of the ASCII file, the screen updates the database with a status of "ready-to-send." The DDM task continuously polls and notifies the DFT task when it detects the readiness of the file. The DFT task uses the ftp "put" to send the file.

12.3.4.4 Conc Ephem

Select the "CONC EPHEM" item in the Req File menu to activate the Oracle form - Conc Ephem. This screen will display the following fields to be populated by the user (if not already populated by the screen) to generate the concentrated definitive ephemeris request file.

- Spacecraft name: Landsat-7
- Start time (DD MM YYYY HH:MM:SS:ms)
- Stop time (DD MM YYYY HH:MM:SS:ms)
- ephemeris interval (time in seconds: N.NNNNN)

The user presses the OK button and the screen updates the database, including filename, and builds the ASCII file. After the creation of the ASCII file, the screen updates the database with a status of "ready-to-send." The DDM task continuously polls and notifies the DFT task when it detects the readiness of the file. The DFT task uses the ftp "put" to send the file.

12.3.5 CAL PARM Menu Item

The Cal Parm Menu has two submenu items:

- Generate
- Send

The following subsections describe the available items under the Cal Parm Menu.

12.3.5.1 Generate

Select the "GENERATE" item in the Cal Parm menu to activate the Oracle form - Generate. This screen prompts the user for the name of the baseline calibration parameter file, the radiometric and geometric CPFs, the UTC correction, and the output directory (optional) then allows the user to press a button to generate the new CPF.

A program runs in the background to generate the file and inserts the appropriate information in the database in the CPF_catalog table, including the filename. The analyst may then review the new CPF. If the new CPF is acceptable, the user then chooses the Send menu from the Cal Parm File pulldown menu.

12.3.5.2 Send

Select the “SEND” item in the Cal Parm menu to activate the Oracle form - Send. This screen displays a list of the IAS generated CPFs (files in the transfer area). It allows the user to

- Select the file that is to be sent
- Press the button to send the selected CPF

After the user presses the button to send the file, the interface screen updates the database with the status of “ready-to-send.” The file will be written to a staging directory for the DAAC to retrieve, using an ftp “get.”

12.3.6 MONITOR Menu Item

The Monitor Menu has four submenu items.

- Events
- L0R Products
- Transfers
- Query Database

The following subsections describe the available items under the Monitor Menu.

12.3.6.1 Events

Select the “EVENTS” item in the Monitor menu to activate the Oracle form - Events. This screen gives the user the option of filtering on work order ID, a time frame, or the program ID (such as DIM for MOC ingest messages)

Both screens provide a scroll bar capability to view all the displayed events. The following fields are displayed on each of the above screens:

- WO ID
- Script ID
- Program ID (task name)
- Event date
- Brief message
- Detailed message (if any)

12.3.6.2 L0R Products

Select the "L0R PRODUCTS" item in the Monitor menu to activate the Oracle form - L0R Products. This screen displays data from the L0R data catalog. The user may not modify any data on this screen. The following are fields that are displayed.

- Product ID a unique identifier
- Associated WO IDs if any
- Delete files whether files should/will/have been deleted
- Path where files reside on disk for that product
- Ingest status whether successful, etc.
- Date file ingested date the file was ingested

12.3.6.3 Transfers

Select the "TRANSFERS" item in the Monitor menu to activate the Oracle form - Transfers. This screen displays the status of all files in the File_Transfer database table. It displays the following fields for transfers via ftp or to tape.

- Request date date of request
- Requester name of requester, if available
- Transfer status status of transfer
- Max attempts for ftp requests only
- Source file file that was ftp'd or written to tape
- Dest name host name or archive tape number

The user is allowed to reset the ftp status to "ready-to-send" (in the event of three times (3x) ftp failure), inferring that any ftp problems have been corrected and the file may be sent again. This may only be done for ftp transfer types.

12.3.6.4 Query Database

Select the "QUERY DATABASE" item in the Monitor menu to activate the Oracle form - Query Database. This screen allows the user the ability to perform ad hoc queries on the database. It has not yet been determined what specific queries will be provided. The user may currently log into sqlplus and perform any queries.

12.4 Analyst User Interface Architecture

The AUI for the IAS uses the ENVI software package to provide a graphical menu-driven window environment for executing evaluation and assessment functions. All functions available through the AUI are begun by selecting menu items. These functions include intrinsic ENVI functions, custom IAS applications, and COTS applications. All details of user input and output are handled by an application. The menu layout provided by ENVI is completely customizable, with the menu items and their associated functions being defined in an ENVI menu configuration file.

12.4.1 Menus and Control

Upon initiation of the AUI, the main menu tool bar is displayed. This tool bar contains a series of pulldown menus that allow the user to perform various functions of the interface. The menus are listed below. Menu items are selected (i.e., invoked) with the mouse by placing the cursor on the name of the desired menu, pressing and holding down the left mouse button, moving the cursor to the desired item, and releasing the button.

There are six major functions for an Analyst.

- Operator Functions
- Image Analysis
- IAS Applications
- Trending Analysis
- Quarterly Reports

The following subsections describe the submenus and the functions under each of the submenus.

12.4.2 OPERATOR FUNCTIONS Menu Item

The OPERATOR FUNCTIONS menu has five submenu items.

- Work Order
- Req File
- Cal Parm File
- Monitor
- DAAC Interface
- Quit

The following subsections describe the available items under the Operator Functions menu

12.4.2.1 WORK ORDER Menu Item

The WORK ORDER menu is a submenu of the Operator Functions menu. The WORK ORDER Menu has twelve submenu items:

- Create New
- Create from Template
- Create Series of WOs
- Update Product ID in a WO
- Delete WO
- Continue WO Processing
- Abort WO Processing
- Mark WO as Analyzed
- WO Status
- Copy Work Order File
- View/Edit Cal Parm File
- View L0R Ingest Report

The following subsections describe the available items under the Work Order menu.

12.4.2.1.1 Create New

Select the "CREATE NEW" item in the Work Order Menu to activate the Oracle form - Create New. This screen allows the user to create a new WO. This function is the same as for the OUI, Section 12.3.3.1.

12.4.2.1.2 Create from Template

Select the "CREATE FROM TEMPLATE" item in the Work Order Menu to activate the Oracle form - Create from Template. This screen allows the user to create a new WO from an existing WO. This function is the same as for the OUI, Section 12.3.3.2.

12.4.2.1.3 Create Series of WOs

Select the "Create Series of WOs" item in the Work Order Menu to activate the Oracle form - Create Series of WOs. This screen allows the user to create a series of WOs for a specific time range. This function is the same as for the OUI, Section 12.3.3.3.

12.4.2.1.4 Update Product ID in a WO

Select the “UPDATE PRODUCT ID in a WO” item in the Work Order Menu to activate the Oracle form - Update Product Id in a WO. This screen allows the user to fill in the L0R product ID in an existing work order. This function is the same as for the OUI, Section 12.3.3.4.

12.4.2.1.5 Delete WO

Select the “DELETE WO” item in the Work Order Menu to activate the Oracle form - Delete WO. This screen allows the user to enter the identification of a WO that requires deletion. This function is the same as for the OUI, Section 12.3.3.5.

12.4.2.1.6 Continue WO Processing

Select the “CONTINUE WO PROCESSING” item in the Work Order Menu to activate the Oracle form - Continue WO Processing. This screen allows the user to enter the identification of a WO that the user wants to continue. This function is the same as for the OUI, Section 12.3.3.6.

12.4.2.1.7 Abort WO Processing

Select the “ABORT WO PROCESSING” item in the Work Order Menu to activate the Oracle form - Abort WO Processing. This screen allows the user to enter the identification of a WO that the user wants to discontinue. This function is the same as for the OUI, Section 12.3.3.7.

12.4.2.1.8 Mark WO as Analyzed

Select the “MARK WO AS ANALYZED” item in the Work Order Menu to activate the Oracle form - Mark WO as Analyzed. This screen allows the user to change the state of a WO from “In Assessment” to “Completed.” This function is the same as for the OUI, Section 12.3.3.8.

12.4.2.1.9 WO Status

Select the “STATUS” item in the Work Order Menu to activate an IDL screen, Status. This screen replicates the functionality of the analogous Oracle form identified for the OUI, Section 12.3.3.6. In addition, this screen allows the user to set the current WO directory by selecting a WO. This relieves the user from having to remember the file system location of files associated with a given WO when invoking other functions via the Analyst User Interface. The screen also displays the value of the current work order directory.

12.4.2.1.10 Copy Work Order Files

Select the “COPY WORK ORDER FILES” item in the Work Order Menu to activate the IDL application that allows the user to copy files from one WO directory (source) to another (destination). The default source directory is the current WO directory, but this may be overridden by the user. No default destination directory is assumed, thus this must be specified. If the named destination directory does not exist, it is created. If a file in an existing destination directory would be overwritten by the operation, a warning is displayed and the user may continue or cancel the copy.

12.4.2.1.11 View/Edit Cal Parm File

Select the “VIEW/EDIT CAL PARM FILE” item in the Work Order Menu to activate an IDL file browser window through which the user my specify a CPF. After the CPF is selected, it is loaded into an editor for viewing and possibly altering and saving.

12.4.2.1.12 View L0R Ingest Report

Select the “VIEW L0R INGEST REPORT” item in the Work Order Menu to activate the IDL file browser through which the user may specify an L0R ingest report file. After the selected, it is loaded into a viewer for inspection.

12.4.2.2 REQ FILE Menu Item

The REQ FILE menu is a submenu of the Operator Functions menu. The REQ FILE menu has four submenu items.

- FAC
- PAC
- GLC
- Conc Ephem

The following subsections describe the available items under the Req File menu.

12.4.2.2.1 FAC

Select the “FAC” item in the Req File Menu to activate an Oracle form - FAC. This screen allows the user to generate a request for a FAC scene. This function is the same as for the OUI, Section 12.3.4.1.

12.4.2.2.2 PAC

Select the “PAC” item in the Req File Menu to activate an Oracle form - PAC. This screen allows the user to generate a request for a PAC scene. This function is the same as for the OUI, Section 12.3.4.2.

12.4.2.2.3 GLC

Select the “GLC” item in the Req File Menu to activate an Oracle form - GLC. This screen allows the user to generate a request for a GLC scene. This function is the same as for the OUI, Section 12.3.4.3.

12.4.2.2.4 Conc Ephem

Select the “CONC EPHEM” item in the Req File Menu to activate an Oracle form - Conc Ephem. This screen allows the user to generate a request for a concentrated ephemeris file. This function is the same as for the OUI, Section 12.3.4.4.

12.4.2.3 CAL PARM FILE Menu Item

The CAL PARM FILE menu is a submenu of the Operator Functions menu. The CAL PARM FILE menu has two submenu items.

- Generate
- Send

The following subsections describe the available items under the Cal Parm File menu.

12.4.2.3.1 Generate

Select the “GENERATE” item in the Cal Parm Req Menu to activate an Oracle form - Generate. This screen allows the user to generate the calibration parameter file. This function is the same as for the OUI, Section 12.3.5.1.

12.4.2.3.2 Send

Select the “SEND” item in the Cal Parm Req Menu to activate an Oracle form - Send. This screen allows the user to send the calibration parameter. This function is the same as for the OUI, Section 12.3.5.2.

12.4.2.4 MONITOR Menu Item

The MONITOR menu is a submenu of the Operator Functions menu. The MONITOR menu has four submenu items.

- Events
- L0R Products
- Transfers
- Query Database

The following subsections describe the available items under the Monitor menu.

12.4.2.4.1 Events

Select the "EVENTS" item in the Monitor menu to activate an Oracle form - Events. This screen allows the user to view events associated with work order processing. This function is the same as for the OUI, Section 12.3.6.1.

12.4.2.4.2 L0R Products

Select the "L0R PRODUCTS" item in the Monitor menu to activate an Oracle form - L0R Products. This screen allows the user to view the fields in the L0R data catalog. This function is the same as for the OUI, Section 12.3.6.2.

12.4.2.4.3 Transfers

Select the "TRANSFERS" item in the Monitor menu to activate an Oracle form - Transfer. This screen allows the user to view the status of all files in the File Transfer database table. This function is the same as for the OUI, Section 12.3.6.3.

12.4.2.4.4 Query Database

Select the "QUERY DATABASE" item in the Monitor menu to activate an Oracle form - Query Database. This screen allows the user to perform ad hoc queries on the database. This function is the same as for the OUI, Section 12.3.6.4.

12.4.2.5 DAAC Interface Menu Item

Select the "DAAC INTERFACE" item in the Operator Functions menu to activate a World Wide Web browser (e.g., Netscape) with the URL of the DAAC. This enables the user to browse and order L0R data products from the DAAC.

12.4.2.6 QUIT

Select the "QUIT" item in the Operator Function to exit the AUI. After the user select this button, the interfaces presents a pop-up confirmation menu screen. Selecting YES on this screen exits the AUI; selecting NO aborts the Quit operations.

12.4.3 IMAGE ANALYSIS Menu Item

The IMAGE ANALYSIS Menu has six top level choices.

- File
- Basic Tools
- Utilities
- Transforms
- Filters
- System

The following subsections describe available submenus under the Image Analysis menu item. The selections below represent the top level choices from the original ENVI main menu that have been retained for use in the AUI. As such, each selection contains submenus appropriate to the item topic. These submenus are not explicitly listed in full here because of their number and because they are documented thoroughly elsewhere (see the ENVI documentation).

12.4.3.1 File

Select the “FILE” item in the Image Analysis Menu to provide access to ENVI functions that pertain to file I/O, such as opening and closing data files, loading image band data, listing available bands, and listing open files.

12.4.3.2 Basic Tools

Select the “BASIC TOOLS” item in the Image Analysis Menu to provide access to ENVI’s basic image functions such as controlling the image display windows, viewing image statistics, getting cursor locations and values, masking and performing band math.

12.4.3.3 Utilities

The “UTILITIES” item in the Image Analysis Menu to provide access to ENVI utility functions such as resizing, rotating, flipping, and mosaicking images, viewing raw data, converting data types, and specifying map projections. Also provided under “Utilities” is access to user-defined functions.

12.4.3.4 Transforms.

Select the “TRANSFORMS” item in the Image Analysis Menu to provide access to ENVI’s image transform functions such as calculating band ratios and performing color transforms, sharpening, and image stretching.

12.4.3.5 Filters.

Select the “FILTERS” item in the Image Analysis Menu to provide access to ENVI’s filter functions such as performing image convolutions, modifying image morphology and texture, applying adaptive filters, and Fast Fourier Transform (FFT) filtering.

12.4.3.6 System

Select the “SYSTEM” item in the Image Analysis Menu to provide access to ENVI’s system-related functions such as displaying on-line help, displaying and editing current ENVI configuration parameters, and displaying the list of widgets that ENVI is currently controlling.

12.4.4 IAS APPLICATIONS Menu Item

The IAS Applications menu has two submenus.

- Radiometric Menu
- Geometric Menu

The following subsections describe available submenus under the IAS Applications menu.

12.4.4.1 RADIOMETRIC Menu Item

The RADIOMETRIC menu has seven submenu items.

- Impulse Noise
- Coherent Noise
- Random Noise
- FASC
- CRaM
- Correct CN

The following subsections identify the available items under the Radiometric menu when the “RADIOMETRIC” item in the IAS Applications Menu is selected.

12.4.4.1.1 Impulse Noise

Select the “IMPULSE NOISE” item in the Radiometric Menu to activate an IDL application that allows the user to perform bit flip classification on the results of the impulse noise characterization algorithm.

12.4.4.1.2 Coherent Noise

Select the “COHERENT NOISE” item in the Radiometric Menu to activate an IDL application that allows the obtain estimates of the variance in the random noise for comparison with the results of the histogram analysis. The estimates are obtained using the results from (CN) algorithm.

12.4.4.1.3 RANDOM NOISE

Select the “RANDOM NOISE” item in the Radiometric Menu to activate an IDL application that allows the user to view reports and plots generated by the algorithm (for IC, FASC, and night scenes) and to convert means and standard deviations to L and NEDL and plot them (for FASC data).

12.4.4.1.4 FASC

Select the “FASC” item to launch an IDL application that allows the user to view reports and plots generated by the algorithm.

12.4.4.1.5 CRaM

Select the “CRaM” item to launch an IDL application that allows the user to perform the gain fitting algorithm on the results of this algorithm. Also, the user may examine the correlation coefficients between the gain functions and analyze output degradation factors.

12.4.4.1.6 Correct CN

Select the “Correct CN” item to launch an IDL application that allows the user to analyze the residual coherent noise components in an image remaining after the application of the coherent noise corrections.

12.4.4.2 Geometric Menu Item

The GEOMETRIC Menu has nine submenu items.

- View TMINIT Report
- Sensor Alignment
- Band-to-Band
- Band Location

- Image-to-Image
- Scan Mirroe Cal
- Geodetic Accuracy Char
- Geometric Accuracy Char
- Precision GCP Solution

The following subsections identify the available items under the Geometric menu when the “GEOMETRIC” item in the IAS Applications Menu is selected

12.4.4.2.1 View TMINIT Report Menu Item

Select the “View TMINIT Report” item to activate an IDL file browser window through which the user may specify the TMINIT report filename. After the file is selected, it is loaded into an viewer for inspection.

12.4.4.2.2 Sensor Alignment Cal

Select the “SENSOR ALIGNMENT CAL” item in the Geometric Menu to activate an IDL application that allows the user to perform the sensor alignment calibration. The exact functionality and layout of this screen are TBD (being developed at EDC).

12.4.4.2.3 Band-to-Band Char

Select the “BAND-TO-BAND CHAR” item in the Geometric Menu to activate an IDL application that allows the user to perform the band-to-band registration characterization. The exact functionality and layout of this screen are TBD (being developed at EDC).

12.4.4.2.4 Band Location Cal

Select the “BAND LOCATION CAL” item in the Geometric Menu to activate an IDL application that allows the user to perform the band location calibration. The exact functionality and layout of this screen are TBD (being developed at EDC).

12.4.4.2.5 Image-to-Image Char

Select the “IMAGE-TO-IMAGE CHAR” item in the Geometric Menu to activate an IDL application that allows the user to perform the image-to-image registration characterization. The exact functionality and layout of this screen are TBD (being developed at EDC).

12.4.4.2.6 Scan Mirror Cal

REVIEW

Select the “SCAN MIRROR CAL” item in the Geometric Menu to activate an IDL application that allows the user to perform the scan mirror calibration. The exact functionality and layout of this screen are TBD (being developed at EDC).

12.4.4.2.7 Geodetic Accuracy Char

Select the "GEODETIC ACCURACY CHAR" item in the Geometric Menu to activate an IDL application that allows the user to perform the geodetic accuracy characterization. The exact functionality and layout of this screen are TBD (being developed at EDC).

12.4.4.2.8 Geometric Accuracy Char

Select the "GEOMETRIC ACCURACY CHAR" item in the Geometric Menu to activate an IDL application that allows the user to perform the geometric accuracy characterization. The exact functionality and layout of this screen are TBD (being developed at EDC).

12.4.4.2.9 Precision GCP Solution

Select the "PRECISION GCP SOLUTION" item in the Geometric Menu to activate an IDL application that allows the user to perform the precision ground control point solution. The exact functionality and layout of this screen are TBD (being developed at EDC).

12.4.5 Trending Analysis

Select the "TRENDING ANALYSIS" item to activate an IDL application that allows the user to perform analysis on the data stored in the trending database. The user is presented, at the top of the initial dialogue window, with the trending type options "Radiometric," "Geometric," and "Ad Hoc." Selection of one of these types causes further selection options based on the algorithm to be presented on the dialogue window. After an algorithm option is selected and confirmed, a new analysis window is brought up to perform the appropriate trending analysis. For "Ad Hoc" analyses, no algorithm need be specified.

If trending of type "Radiometric" or "Geometric" is chosen, the user is presented on the analysis window with a list of options for executing "canned" scripts appropriate for the chosen type and algorithm. If trending of type "Ad Hoc" is chosen, the user is presented with a list of parameters available for trending. In both cases, the user may specify filter parameters appropriate to the type of trending being performed. Once the trending script or parameters are specified together with any filter parameters, the user submits the request, the application retrieves the data and produces the plot. The user may also inspect the numerical values of the data and also save the plot to a file for later incorporation into reports. In some cases, a limited function-fitting capability is available. The user may superimpose plots and overplot spec values. Also, basic statistics of the plotted data are calculated and made available for inspection.

12.4.6 Quarterly Reports

The following selections, described in more detail below, are available under the "Quarterly Reports" menu item:

- Generate
- Stage
- Send

12.4.6.1 Generate Menu Item

Select the "Generate" item to activate an IDL window that allows the user to specify the report type to generate. The user is presented at the top of the window with the options "Calibration Reports," "Assessment Reports," "Evaluation Reports," "Anomaly Resolution Reports," and "Other." Selection of one of these options causes further selections appropriate to the chosen option to appear. The following selections are available after choosing "Calibration Reports"

- Sensor Alignment
- Band-to-Band Registration
- Detector Delay
- Radiometric

The following selections are available after choosing "Assessment Reports":

- Detector Operability
- Radiometric Accuracy
- Streaking and Banding
- Correlated and Coherent Noise
- MTF
- SNR
- Geodetic Accuracy
- Geometric Accuracy
- Band-to-Band Registration Accuracy
- Image-to-Image Registration Accuracy
- Image Artifacts

The following selections are available after choosing “Evaluation Reports”:

- LPS Data Quality
- Level 0R Data and Products
- Level 1R Data Quality
- PCD Quality
- Selected Trend Analyses

No further selections are available for the “Anomaly Resolution” and “Other” options. The user may then specify whether to create a new report or to modify an existing unfinished report. At this point the user selects “OK” to launch FrameMaker loaded with the appropriate template (for new reports) or file (for existing reports), “Cancel” to exit the window. All reports in the process of being generated are stored in a dedicated reports directory.

12.4.6.2 Stage

Select the “STAGE” item to activate an IDL application that enables the user to move a report from the reports directory to a staging directory for retrieval by the DAAC. Initially the user is presented with a file browser window from which the user selects the report to be staged. The user then selects “Move Report” to stage the report; “Cancel” to exit the window.

12.4.6.3 Send

Select the “SEND” item to activate a World Wide Web browser (e.g., Netscape) with the appropriate URL of the DAAC. This enables the user to notify the DAAC of the location of completed IAS reports ready to be retrieved.

12.4.7 Quit

Select the “QUIT” item to exit the Analyst User Interface. After the user selects this button, the interface presents a pop-up confirmation screen. Selecting YES on this screen exits the Analyst User Interface, NO cancels the function.

Appendix A. Requirements Traceability

This appendix presents the IAS requirements traceability. The first table A – 1,shows the mapping between the IAS system and derived requirements and the IAS software tasks. The second table A – 2, shows the mapping between the IAS software tasks and the IAS system or derived requirements.

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
3.2.1.1.1	The IAS shall interface with the EDC DAAC for purposes of searching for and ordering of data from the Landsat 7 archive.	Operator User Interfacen
3.2.1.1.2	The IAS shall receive Level 0R data, Level 0R products, and associated ancillary data from the EDC DAAC.	Data Manager, Ingest 0R Files
3.2.1.1.3	The IAS shall interface with the EDC DAAC to coordinate the transfer of calibration parameter files and IAS-generated reports.	N/A
3.2.1.1.4	The IAS shall send calibration parameter files and IAS-generated reports to the EDC DAAC.	Data Manager, Format Transmit
3.2.1.2.1	The IAS shall interface with the LPS to coordinate the transfer of calibration parameter files and reprocessing requests.	N/A
3.2.1.2.2	The IAS shall send reprocessing requests to the LPS.	N/A
3.2.1.2.3	The IAS shall receive disposition of reprocessing requests from the LPS.	N/A
3.2.1.2.4	The IAS shall send calibration parameter files to the LPS.	Data Manager, Format Transmit
3.2.1.3.1	The IAS shall send requests to the MOC for the operational acquisition of partial-aperture calibration data, full-aperture calibration data, and surface image data of radiometric and geometric calibration ground sites.	Operator User Interface, Data Manager, Format Transmit
3.2.1.3.2	The IAS shall coordinate with the MOC for the acquisition of ETM+ imagery required for calibration and image assessment, for the transfer of calibration parameter files, and for the transfer of problem reports.	N/A
3.2.1.3.3	The IAS shall send requests to the MOC for concentrated definitive ephemeris.	Operator User Interface, Data Manager, Format Transmit
3.2.1.3.4	The IAS shall send problem reports to the MOC.	Operator User Interface, Data Manager, Format Transmit

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
3.2.1.3.5	The IAS shall send calibration parameter files to the MOC.	Operator User Interface, Data Manager, Format Transmit
3.2.1.3.6	The IAS shall be capable of receiving telemetry trend reports, spacecraft status reports, and event schedules from the MOC.	Ingest MOC Files
3.2.1.3.7	The IAS shall be capable of receiving Flight Dynamics Facility (FDF)-generated, definitive ephemeris from the MOC.	Ingest MOC Files
3.2.1.4.1	The IAS shall send problem reports and summary reports to the MMO.	N/A
3.2.2.1.1	The IAS shall be able to use data from the internal calibrator in the calibration of the radiometric response of each ETM+ detector.	L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c)
3.2.2.1.2	The IAS shall be able to calibrate the radiometric response of each ETM+ detector, except band 6, using data from the partial-aperture solar calibrator (PASC).	L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r)
3.2.2.1.3	The IAS shall be able to calibrate the radiometric response of each ETM+ detector, except band 6, using data from the full-aperture solar calibrator (FASC).	L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r)
3.2.2.1.4	The IAS shall be able to calibrate the radiometric response of each ETM+ detector given Level 0R data of a ground calibration site and corresponding at-aperture spectral radiance values.	L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c)
3.2.2.1.5	The IAS shall be able to calibrate the radiometric response of each ETM+ detector using Level 0R data from preship and prelaunch calibration sources and auxiliary calibration source data.	L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c)
3.2.2.1.6	The IAS shall have the capability of assessing the short-term and long-term stability of the onboard calibration sources, which include the FASC, the PASC, and the internal calibrators.	L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c)
3.2.2.1.7	The IAS shall be able to integrate the results of the various calibration processes into an optimal estimate of radiometric calibration of each detector (except band 6) and provide new calibration parameters.	L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r)
3.2.2.1.8	The IAS shall be capable of generating radiometric calibration updates for the calibration parameter file.	L0R Characterization and Correction (r0r)
3.2.2.1.9	The IAS shall be able to transfer the calibration of each detector to the internal calibrator.	L0R Characterization and Correction (r0r)

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
3.2.2.2.1	The IAS shall be capable of determining the misalignment between the satellite navigational base reference and the ETM+ payload line-of-sight (LOS).	Geometric Processing
3.2.2.2.2	The IAS shall be capable of determining band-to-band registration parameters.	Geometric Processing
3.2.2.2.3	The IAS shall be capable of characterizing and updating along and across scan parameters (i.e., scan mirror profiles, scan-line corrector mirror profile, detector offsets, detector delays).	Geometric Processing
3.2.2.2.4	The IAS shall be capable of generating geometric calibration updates for the calibration parameter file.	Geometric Processing
3.2.2.3.1	The IAS shall be capable of processing payload correction data (PCD) data to correct spacecraft time, generate a sensor pointing model (attitude and jitter), and calculate spacecraft position and velocity (ephe+meris).	Geometric Processing, Ingest 0R Files
3.2.2.3.2	The IAS shall be capable of processing ETM+ Level 0R products to produce radiometrically corrected Level 1R image data.	L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r)
3.2.2.3.3	The IAS shall be capable of creating systematically corrected ETM+ Level 1G imagery from Level 0R products.	L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c), Geometric Processing
3.2.2.3.4	The IAS shall be capable of creating precision corrected ETM+ Level 1G imagery from Level 0R products and ground control points (GCPs).	L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c), Geometric Processing
3.2.2.3.5	The IAS shall be capable of creating terrain corrected ETM+ Level 1G imagery from Level 0R products, GCPs, and elevation data.	L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c), Geometric Processing
3.2.2.3.6	The IAS shall be capable of performing image-to-image registration.	Geometric Processing
3.2.2.3.7	The IAS shall be capable of incorporating IAS-generated calibration coefficient updates to generate Level 1 data.	L1R Characterization and Correction (r1r), Geometric Processing
3.2.2.3.8	The IAS shall support nearest neighbor, cubic convolution, and modulation transfer function (MTF) compensation resampling.	Geometric Processing
3.2.2.3.9	The IAS shall have the capability to produce a 1G product with a grid cell size that is variable from 15 to 60 meters, in increments of 1 millimeter	Geometric Processing

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
	(mm).	
3.2.2.3.10	The IAS shall have the capability to map project 1G using the Space Oblique Mercator, Universal Transverse Mercator, Lambert Conformal Conic, Transverse Mercator, Oblique Mercator, and Polyconic coordinate reference systems.	Geometric Processing
3.2.2.3.11	The IAS shall have the capability to create a 1G image oriented to nominal path or north-up.	Geometric Processing
3.2.2.3.12	The IAS shall be capable of processing Mirror Scan Correction Data (MSCD) to generate scan mirror and scan line corrector mirror models	Geometric Processing
3.2.2.3.13	The IAS shall be capable of compensating for inoperable and saturated detectors during Level 1R and 1G processing.	L1R Characterization and Correction (r1r), Geometric Processing
3.2.2.3.14	The IAS shall be capable of compensating for the image artifacts of striping, banding, coherent noise, memory effect, and scan correlated shift in Level 1R and 1G processing.	L1R Characterization and Correction (r1r), Geometric Processing
3.2.2.3.15	The IAS shall be capable of processing to Level 1R and 1G both ascending and descending pass ETM+ Level 0R data.	L1R Characterization and Correction (r1r), Geometric Processing
3.2.2.4.1	The IAS shall evaluate the on-orbit operability of ETM+ detectors.	L1R Characterization and Correction (r1r), Geometric Processing
3.2.2.4.2	The IAS shall be able to evaluate the absolute radiometric accuracy of ETM+ Level 0R, 1R, and 1G data.	L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r), Geometric Processing
3.2.2.4.3	The IAS shall be able to assess the identified ETM+ radiometric image artifacts of striping; banding; random, correlated, and coherent noise; memory effect; and scan-correlated shift.	L0R Characterization and Correction (r0r),
3.2.2.4.4	The IAS shall be able to evaluate the MTF of each ETM+ detector.	L1R Characterization and Correction (r1r)
3.2.2.4.5	The IAS shall be able to evaluate the signal-to-noise ratio (SNR) of each ETM+ detector, using prelaunch and on-orbit image data.	L1R Characterization and Correction (r1r)
3.2.2.4.6	The IAS shall be capable of evaluating the on-orbit radiometric response of each ETM+ detector with respect to dynamic range.	L1R Characterization and Correction (r1r)
3.2.2.4.7	The IAS shall be capable of evaluating the on-orbit radiometric response of each ETM+ detector, excluding band 6, with respect to linearity (TBD).	L1R Characterization and Correction (r1r)

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
3.2.2.4.8	The IAS shall be able to evaluate the geodetic accuracy of ETM+ Level 1G image data.	Geometric Processing
3.2.2.4.9	The IAS shall be able to evaluate the internal geometric accuracy of ETM+ Level 1G image data	Geometric Processing
3.2.2.4.10	The IAS shall be able to evaluate the band-to-band registration accuracy of ETM+ imagery.	Geometric Processing
3.2.2.4.11	The IAS shall be able to evaluate the image-to-image registration accuracy of ETM+ data.	Geometric Processing
3.2.2.4.12	The IAS shall be able to evaluate the quality of Level 0R products. Quality checks will include but not be limited to those listed in Table 3.2.2.4-1.	Ingest 0R Files, L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r)
3.2.2.4.12a	The IAS shall provide the capability to visually check L0R Product imagery.	Analyst User Interface
3.2.2.4.12b	The IAS shall range check all but the housekeeping parameters in the L0R Product Payload Correction Data.	Ingest 0R Files
3.2.2.4.12c	The IAS shall validate scan direction consistency in the L0R Product Mirror Scan Correction Data.	Ingest 0R Files
3.2.2.4.12d	The IAS shall validate FHSERR/SHSERR consistency in the L0R Product Mirror Scan Correction Data.	Ingest 0R Files
3.2.2.4.12e	The IAS shall validate counted line length consistency in the L0R Product Mirror Scan Correction Data.	Ingest 0R Files
3.2.2.4.12f	The IAS shall validate dropped line locations in the L0R Product Mirror Scan Correction Data.	L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r)
3.2.2.4.12g	The IAS shall validate the consistency of the applicability date in the Calibration Parameter File with the L0R Product image files.	Ingest 0R Files
3.2.2.4.12h	The IAS shall validate the consistency of the Calibration Parameter File of the L0R Product with the IAS database.	Ingest 0R Files
3.2.2.4.12I	The IAS shall support validation of ACCA scores from the L0R Product metadata through visual inspection of the associated L0R image files.	Analyst User Interface
3.2.2.4.12j	The IAS shall validate scene coordinates from the L0R Product metadata.	Ingest 0R Files
3.2.2.4.12k	The IAS shall validate file name consistency from the L0R Product metadata.	Ingest 0R Files
3.2.2.4.12l	The IAS shall validate the correctness of WRS scene parameters from the L0R Product metadata.	Ingest 0R Files
3.2.2.4.12m	The IAS shall validate calibration outliers in the L0R Product Calibration Pulse/Shutter data.	L0Rc Characterization and Correction (r0c), L1R Characterization and Correction

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
		(r1r)
3.2.2.4.12n	The IAS shall validate shutter means in the L0R Product Calibration Pulse/Shutter data.	L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r)
3.2.2.4.12o	The IAS shall validate shutter standard deviations in the L0R Product Calibration Pulse/Shutter data.	L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r)
3.2.2.4.12p	The IAS shall validate shutter outliers in the L0R Product Calibration Pulse/Shutter data.	L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r)
3.2.2.4.13	The IAS shall be capable of performing a trend analysis over any desired time interval for each selected evaluation activity.	Analyst User Interface
3.2.2.4.15	The IAS shall provide the capability to visually inspect image data.	Analyst User Interface
3.2.2.4.16	The IAS shall provide a capability that allows an image analyst to monitor assessment processes and results.	Analyst User Interface
3.2.2.4.17	The IAS shall have the capability to review output data, including but not limited to calibration reports and updates.	Analyst User Interface
3.2.2.5.1	The IAS shall have the capability to acquire, develop, test, and add new algorithms and software to improve the radiometric and geometric properties of ETM+ data and their assessment without impacting IAS operations.	Operator User Interface, WO Scheduler, WO Controller
3.2.2.5.2	The IAS shall support the development of algorithms to remove image artifacts and detector outages from Level 1R and 1G data without impacting normal IAS operations.	N/A
3.2.2.5.3	The IAS shall have the capability to incorporate new algorithms into the operational system without impacting normal IAS operations.	Operator User Interface, WO Scheduler, WO Controller
3.2.2.5.4	The IAS shall maintain configuration control of all algorithms, databases, software, and hardware used in operations.	N/A
3.2.2.6.1	The IAS shall provide the capability to select the processing to be applied to data sets.	Operator User Interface
3.2.2.6.2	The IAS shall be capable of archiving all software and databases used in operations.	Resource Manager
3.2.2.6.3	The IAS shall be capable of storing selected data, parameters, ancillary data, reports, and documents.	Operator User Interface

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
3.2.2.6.4	The IAS shall have the ability to monitor and control processes.	Startup IAS S/W, WO Scheduler, WO Controller
3.2.2.6.5	The IAS shall be capable of storing selected GCPs and GCP chips.	Geometric Processing
3.2.2.6.6	The IAS shall be capable of storing selected digital elevation models (DEMs).	Geometric Processing
3.2.2.6.7	Deleted.	N/A
3.2.2.6.8	The IAS shall be capable of storing solar spectral and broadband radiance data.	CRaM
3.2.2.6.9	The IAS shall have the capability to write outputs to tape.	Operator User Interface, Resource Manager
3.2.2.6.10	The IAS shall have the capability to generate hardcopy outputs.	Operator User Interface, Analyst User Interface
3.2.2.6.11	The IAS shall archive selected prelaunch data, including but not limited to sensor engineering, ETM+ image data, alignment matrices, calibration measurements, mirror scan profiles, FASC bi-directional reflectance distribution function (BRDF), etc.	CRaM, Geometric Processing
3.2.2.6.12	The IAS shall allow the operator to select thresholds for results and errors reported by the IAS.	Operator User Interface
3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.	Operator User Interface, WO Scheduler, Resource Manager, Ingest 0R Files, L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r), CRaM, Geometric Processing
3.2.2.7.1	The IAS shall generate calibration, data quality assessment, and problem reports.	Ingest 0R Files, Ingest MOC Files, CRaM, Geometric Processing
3.2.2.7.2	The IAS shall be capable of generating metadata for all reports sent to the EDC DAAC Guide Server.	Format Transmit Files
3.2.2.7.3	The IAS shall generate annual reports that document calibration coefficient and performance analysis trends.	Analyst User Interface
3.2.2.7.4	The IAS shall generate reports of anomaly detection analyses as they are concluded.	Analyst User Interface

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
3.2.2.7.5	The IAS shall generate processing summaries after each IAS activity.	Ingest 0R Files, Format Transmit Files, Ingest MOCC Files, WO Schedule, WO Controller, L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r), CRaM, Geometric Processing
3.2.3.1	The IAS shall be capable of calibrating the radiometric response (absolute spectral radiance) of each operable ETM+ detector to an accuracy of 5 percent, 1 sigma, providing all inputs are within specification.	L1R Characterization and Correction (r1r)
3.2.3.2	The IAS shall be capable of calibrating the relative radiometric response such that the ratio of ETM+ equivalent at-aperture radiances between any combination of two spectral bands, excluding band 6, shall vary less than 2 percent, 1 sigma, over a 7-day p	L1R Characterization and Correction (r1r)
3.2.3.3	The IAS shall contribute no greater than 0.7 percent uncertainty to absolute radiometric accuracy during the generation of Level 1R and 1G data.	L1R Characterization and Correction (r1r), Geometric Processing
3.2.3.4	The IAS shall be able to create systematic imagery to a geodetic accuracy of 250 meters, 1 sigma, providing all inputs are within specification. Performance applies to along-track and cross-track directions and is referenced to a nadir-viewing geometry.	Geometric Processing
3.2.3.5	The IAS shall contribute circular errors no greater than 1.8 meters, 1 sigma, in the production of systematically corrected ETM+ Level 1G imagery. This error is referenced to a nadir-viewing geometry and excludes the effect of terrain correction.	Geometric Processing
3.2.3.6	The IAS shall provide the capability to register pixels from a band to the corresponding pixels of the other bands in a common scene to an accuracy of 0.28 sensor guide star data (GSD), 0.9p, in along-track and cross-track directions, providing all inputs	Geometric Processing
3.2.3.7	The IAS shall contribute error no greater than 0.11 multispectral sensor GSD, 0.9p, along-track, and 0.24 multispectral sensor GSD, 0.9p, cross-track, in the assessment of band-to-band registration.	Geometric Processing

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
3.2.3.8	The IAS shall provide the capability to perform image-to-image registration to an accuracy of 0.4 multispectral sensor GSD, 0.9p, in the along-track and cross-track directions providing all inputs are within specification.	Geometric Processing
3.2.3.9	The IAS shall contribute circular errors no greater than 3.6 meters, 1 sigma, during image-to-image registration correction of ETM+ Level 1G data. Error is referenced to a nadir-viewing geometry and excludes the effect of terrain correction.	Geometric Processing
3.2.3.10	The IAS shall be capable of estimating the field angles to an accuracy of 0.18 arcsec, 1 sigma.	Geometric Processing
3.2.3.11	The IAS shall be capable of digitally correlating common features in separate bands of the same image or same bands of separate images to an accuracy of 0.1 pixel, 0.9p.	Geometric Processing
3.2.3.12	The IAS shall be capable of estimating the alignment of the ETM+ line-of-sight to the satellite navigation base reference to an accuracy of 24 arcsec, 1 sigma, in all axes.	Geometric Processing
3.2.3.13	Deleted.	N/A
3.2.3.14	he IAS shall be capable of generating the equivalent of up to 10 ETM+ Level 1G systematically corrected scenes in a 24-hour day over the life of the mission. (NOTE: This requirement is meant to size the maximum capacity of the system.)	N/A
3.2.3.15	The IAS shall be capable of receiving and storing 10 ETM+ Level 0R scene products or equivalent per day of data from the EDC DAAC.	Operator User Interface, Data Manager, Ingest 0R Files, Resource Manager
3.2.3.16	The IAS shall be capable of archiving test site image data (initial, intermediate, and final products), characterization data, calibration data, calibration parameter files, and reports, generated by the IAS, over the life of the mission.	Operator User Interface, Resource Manager
3.2.3.17	The IAS shall generate monthly reports that document the quality of 0R data and 0R products retrieved from the EDC DAAC.	Analyst User Interface
3.2.3.18	The IAS shall provide regular calibration and performance updates to the EDC DAAC and other interfaces quarterly.	Analyst User Interface, Data Manager, Format Transmit Files
3.2.3.19	The IAS shall provide an annual Landsat 7 image quality report.	Analyst User Interface
3.2.3.20	The IAS shall have an on-line data storage capacity of 100 gigabytes (GB) (TBR) for image data.	Resource Manager

Table A – 1 IAS System Requirements to IAS Software Tasks		
Reqt No.	**Requirement Statement**	**IAS Software Tasks**
3.2.3.21	The IAS shall be capable of storing 68 megabytes (MB) of GCP data (points, chips, metadata).	Geometric Processing
3.2.3.22	The IAS shall capable of storing 20 GB of elevation data.	Geometric Processing
3.2.4.1	Deleted.	N/A
3.2.4.2	The IAS shall support end-to-end testing at least 12 (TBR) months before launch.	N/A
3.2.4.3	The IAS shall be capable of supporting full operations at launch -6 months.	N/A
3.2.4.4	The IAS shall support mission operations for a minimum of 5 years following in-orbit checkout (IOC).	N/A
3.2.4.5	The IAS shall operate two shifts for 7 days a week during IOC plus 48 days (TBR).	N/A
3.2.4.6	The IAS shall be staffed during prime shift post-IOC plus 48 days (TBR).	N/A
3.2.4.7	The IAS shall ensure backup of all on-line data and operations software.	Operator User Interface, Resource Manager
3.2.4.8	• The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.	Operator User Interface, Data Manager, Ingest 0R Files, Ingest MOCC Files, Rresource Manager, WO Scheduler, WO Controller, L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c), L1R Characterization and Correction (r1r), CRaM, Geometric Processing
3.2.4.8a	The IAS shall perform sensor alignment calibrations calibrations.	Geometric Processing
3.2.4.8b	The IAS shall perform band-to-band registrations.	Geometric Processing
3.2.4.8c	The IAS shall perform detector delay calibrations.	Geometric Processing
3.2.4.8d	The IAS shall perform radiometric calibrations.	L1R Characterization and Correction (r1r)
3.2.4.8e	The IAS shall generate calibration reports quarterly.	Geometric Processing, CRaM
3.2.4.8f	The IAS shall perform detector operability assessments.	L1R Characterization and Correction (r1r)
3.2.4.8g	The IAS shall perform radiometric accuracy assessments.	L1R Characterization and Correction (r1r)
3.2.4.8h	The IAS shall perform streaking and banding assessments.	L1R Characterization and Correction (r1r)
3.2.4.8i	The IAS shall perform correlated and coherent noise assessments.	L1R Characterization and Correction (r1r)

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
3.2.4.8j	The IAS shall perform MTF assessments.	L1R Characterization and Correction (r1r)
3.2.4.8k	The IAS shall perform SNR assessments.	L1R Characterization and Correction (r1r)
3.2.4.8l	The IAS shall perform geodetic accuracy assessments.	L1R Characterization and Correction (r1r)
3.2.4.8m	The IAS shall perform geometric accuracy assessments.	L1R Characterization and Correction (r1r)
3.2.4.8n	The IAS shall perform Band-to-band registration accuracy.	L1R Characterization and Correction (r1r)
3.2.4.8o	The IAS shall perform Image-to-image registration accuracy.	L1R Characterization and Correction (r1r)
3.2.4.8p	The IAS shall perform Image artifact assessments.	L1R Characterization and Correction (r1r)
3.2.4.8q	The IAS shall generate assessment reports quarterly.	Geometric Processing, CRaM
3.2.4.8r	The IAS shall evaluate LPS data quality.	Analyst User Interface, Ingest 0R Files
3.2.4.8s	The IAS shall evaluate Level 0R data and products.	Ingest 0R Files, L0R Characterization and Correction (r0r), L0Rc Characterization and Correction (r0c), Geometric Processing
3.2.4.8t	The IAS shall evaluate Level 1R data quality.	L1R Characterization and Correction (r1r), CRaM
3.2.4.8u	The IAS shall evaluate PCD quality.	Ingest 0R Files, Geometric Processing
3.2.4.8 v	The IAS shall generate evaluation reports on a monthly, quarterly, and annual basis.	Analyst User Interface
3.2.4.8w	The IAS shall perform selected trend analyses.	Analyst User Interface
3.2.4.9	The IAS shall have the capability to maintain and upgrade all operational software.	N/A
3.2.4.10	The IAS shall be capable of supporting training without impacting daily work loads.	N/A
3.2.4.11	The IAS shall provide an operational availability of 0.85 (TBR) or better for all processing functions.	N/A
3.2.4.12	The IAS shall support a mean-time-to-restore (MTTR) capability of 12 (TBR) hours or better.	N/A
3.2.4.13	The IAS shall be capable of retrieving cross-calibration data of other sensors from the EDC DAAC.	Operator User Interface, Data Manager, Ingest 0R Files
3.2.4.14	The IAS capability shall be used in performing anomaly assessment, resolution, and reporting.	Operator User Interface, Analyst User Interface, WO Scheduler, WO Controller
DMS-1	DMS shall extract and store individual files from the Level 0R Product.	Ingest L0R Files, Ingest L0R Files from Tape, Data Manager

Table A – 1 IAS System Requirements to IAS Software Tasks		
Reqt No.	**Requirement Statement**	**IAS Software Tasks**
DMS-2	DMS shall maintain internal directories for storing intermediate products during WO process	Ingest L0R Files, Ingest L0R Files from Tape, Data Manager, Resource Manager
DMS-3	DMS shall maintain a catalog of data by IAS	Data Manager, Resource Manager
DMS-4	DMS shall communicate for data exchange with external systems.	Data Manager, Format Transmit Data,
DMS-5	DMS shall extract Calibrated Parameter fields from the IAS database and formate the CPF for distribution to external systems.	Data Manager, Format Transmit Data
E&A -1	E&A shall provide the following capabilities for displaying WO inputs, intermediate results, and outputs:	
E&A-1.1	• Display ASCII text reports from Run Log	Editor (COT)
E&A-1.10	• Formatted dump of image datasets	ENVI (COT)
E&A-1.11	• Hardcopy print of image datasets	ENVI (COT)
E&A-1.2	• Formated display of binary non-image system inputs and intermediate datasets	Analyst User Interface, View L0R Ingest Reports
E&A-1.3	• Color display of L0R and intermediate image datasets	ENVI (COT)
E&A-1.4	• Scrolling over entire image	ENVI (COT)
E&A-1.5	• Contrast stretch capability for individual line (detector), band or all bands displayed.	ENVI (COT)
E&A-1.6	• Windowing for multiple bands or multiple scenes	ENVI (COT)
E&A-1.7	• Color display of up to three overlaid bands of image data at resolution from sub-scene full resolution to HDF sub-sampletd resolution with capability of zooming between resolution levels.	ENVI (COT)
E&A-1.8	• Image mosaicing capability	ENVI (COT)
E&A-1.9	• Display of line/pixel coordinates and pixel values at designated cursor locations	ENVI (COT)
E&A-2	E&A shall provide the following data analysis capabilities:	
E&A-2.1	• Pixel arithmetic functions for multiple band combinations	ENVI (COT)
E&A-2.2	• Histogram analysis	ENVI (COT)
E&A-2.3	• FFT analyis	ENVI (COT)
E&A-2.4	• Statistical analysis package	ENVI (COT)
E&A-2.5	• Trending of selected parameters, including regression/curve fitting with measures of quality fit	Perform Trending Analysis
E&A-2.6	• Canned trending scripts for standard trending	Perform Trending Analysis

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
	plots •	
E&A-2.7	• 1D, 2D, and 3D plotting capability, including scatter plots, line plots, image displays, contour, wireframe and shaded-surface displays.	Perform Trending Analysis
E&A-2.8	• Screen display of all plots/reports	Perform Trending Analysis, FrameMaker (COT)
E&A-2.9	• Control Point coorelation capability	Geometric Processing
E&A-3	E&A shall provide the capability to edit system input files, including image, PCD, MSCD, and CPFs in support of “what if” analyses. E&A shall provide editable forms and perform sanity checks of modifed parameters before accepting them.	ENVI (COT), Analyst User Interface
E&A-4	E&A shall provide a user interface to cusom IAS applications for radiometric and geometric assessment and evaluation. The Analyst and Operator interfaces shall have the same.	Analyst User Interface, Operator User Interface
E&A-5	E&A shall provide the capability to generate reports summarizing ETM+ instructment and IAS system perfomance	FrameMaker (COT)
E&A-6	E&A shall provide the capability to insert plots and other statistical measures output by E&A data analysis applications into an analyst-generated report.	FrameMaker (COT)
PCS-1	The user shall be able to interactively enter or update a WO specifiying the processing tobe performed.	Operator User Interface, Analyst User Interface
PCS-2	Both standard batch and “what if” processing shall be accommodated. The IAS shall segregate data generated during “what if” processing from that generated during standard batch processing.	Operator User Interface, Analyst User Interface, WO Controller, WO Scheduler, RPS/GPS WO Script
PCS-3	The IAS shall allow the Operator to assign priorities to WOs and shall execute WOs in priority sequence.	Operator User Interface, Analyst User Interface, WO Scheduler, WO Controller
PCS-4	The IAS shall provide the capability to generate and modify procedures specifying processing to perform.	Operator User Interface, Analyst User Interface
PCS-5	The IAS shall provide the capability to pause the execution of a WO at the predefined points and to continue the processing of a WO on user command.	Operator User Interface, Analyst User Interface, WO Scheduler, WO Controller , RPS/GPS WO Script
PCS-6	The IAS shall maintain the status of WOs.	WO Scheduler, WO Controller, Data Manager, Resource Manager

Table A – 1 IAS System Requirements to IAS Software Tasks

Reqt No.	Requirement Statement	IAS Software Tasks
PCS-7	The information associated with a WO shall be kept for the life of the mission.	WO Controller, Data Manager, Resource Manager
PCS-8	The information maintained with each WO shall include (but is not limited to) the following: • Unique WO ID • Date/time WO entered • Name of Requester • Type of request (e.g., standard, custom, test, etc.) • Image input file(s) • Date/time input file(s) requested • Date/time input file(s) received • Processing procedure to be performed on each file • Status of each processing step performed • Action prior to starting next step (e.g., pause for analysis) • Desired completion date • Date/time of completion WO • Current status of WO (e.g., in progress, complete, withdrawn, etc.) • WO priority	Operator User Interface, Analyst User Interface, WO Scheduler, WO Controller

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
Startup IAS Software	3.2.2.6.4	The IAS shall have the ability to monitor and control processes.
WO Scheduler	3.2.2.5.1	The IAS shall have the capability to acquire, develop, test, and add new algorithms and software to improve the radiometric and geometric properties of ETM+ data and their assessment without impacting IAS operations.
	3.2.2.5.3	The IAS shall have the capability to incorporate new algorithms into the operational system without impacting normal IAS operations.
	3.2.2.6.4	The IAS shall have the ability to monitor and control processes.
	3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.
	3.2.2.7.5	The IAS shall generate processing summaries after each IAS activity.
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
	PCS-2	Both standard batch and “what if” processing shall be accommodated. The IAS shall segregate data generated during “what if” processing from that generated during standard batch processing.
	PCS-3	The IAS shall allow the Operator to assign priorities to WOs and shall execute WOs in priority sequence.
	PCS-5	The IAS shall provide the capability to pause the execution of a WO at the predefined points and to continue the processing of a WO on user command.
	PCS-6	The IAS shall maintain the status of WOs.
	PCS-8	The information maintained with each WO shall include (but is not limited to) the following: • Unique WO ID • Date/time WO entered • Name of Requester • Type of request (e.g., standard, custom, test, etc.) • Image input file(s) • Date/time input file(s) requested • Date/time input file(s) received • Processing procedure to be performed on each file • Status of each processing step performed • Action prior to starting next step (e.g., pause for analysis) • Desired completion date • Date/time of completion WO • Current status of WO (e.g., in progress, complete, withdrawn, etc.) • WO priority
WO Controller	3.2.2.5.1	The IAS shall have the capability to acquire, develop, test, and add new algorithms and software to improve the radiometric and geometric properties of ETM+ data and their assessment without impacting IAS operations.
	3.2.2.5.3	The IAS shall have the capability to incorporate new algorithms into the operational system without impacting normal IAS operations.

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
	3.2.2.6.4	The IAS shall have the ability to monitor and control processes.
	3.2.2.7.5	The IAS shall generate processing summaries after each IAS activity.
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
	3.2.4.14	The IAS capability shall be used in performing anomaly assessment, resolution, and reporting.
	PCS-2	Both standard batch and “what if” processing shall be accommodated. The IAS shall segregate data generated during “what if” processing from that generated during standard batch processing.
	PCS-3	The IAS shall allow the Operator to assign priorities to WOs and shall execute WOs in priority sequence.
	PCS-5	The IAS shall provide the capability to pause the execution of a WO at the predefined points and to continue the processing of a WO on user command.
	PCS-6	The IAS shall maintain the status of WOs.
	PCS-7	The information associated with a WO shall be kept for the life of the mission.
	PCS-8	The information maintained with each WO shall include (but is not limited to) the following: • Unique WO ID • Date/time WO entered • Name of Requester • Type of request (e.g., standard, custom, test, etc.) • Image input file(s) • Date/time input file(s) requested • Date/time input file(s) received • Processing procedure to be performed on each file • Status of each processing step performed • Action prior to starting next step (e.g., pause for analysis) • Desired completion date • Date/time of completion WO • Current status of WO (e.g., in progress, complete, withdrawn, etc.) • WO priority
Data Management	3.2.1.1.2	The IAS shall receive Level 0R data, Level 0R products, and associated ancillary data from the EDC DAAC.
	3.2.1.1.4	The IAS shall send calibration parameter files and IAS-generated reports to the EDC DAAC.
	3.2.1.2.4	The IAS shall send calibration parameter files to the LPS.
	3.2.1.3.1	The IAS shall send requests to the MOC for the operational acquisition of partial-aperture calibration data, full-aperture calibration data, and surface image data of radiometric and geometric calibration ground sites.
	3.2.1.3.3	The IAS shall send requests to the MOC for concentrated definitive ephemeris.

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
	3.2.1.3.4	The IAS shall send problem reports to the MOC.
	3.2.1.3.5	The IAS shall send calibration parameter files to the MOC.
	3.2.3.15	The IAS shall be capable of receiving and storing 10 ETM+ Level 0R scene products or equivalent per day of data from the EDC DAAC.
	3.2.3.18	The IAS shall provide regular calibration and performance updates to the EDC DAAC and other interfaces quarterly .
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
	3.2.4.13	The IAS shall be capable of retrieving cross-calibration data of other sensors from the EDC DAAC.
	DMS-1	DMS shall extract and store individual files from the Level 0R Product.
	DMS-2	DMS shall maintain internal directories for storing intermediate products during WO process
	DMS-3	DMS shall maintain a catalog of data by IAS
	DMS-4	DMS shall communicate for data exchange with external systems.
	DMS-5	DMS shall extract Calibrated Parameter fields from the IAS database and formate the CPF for distribution to external systems.
	PCS-6	The IAS shall maintain the status of WOs.
	PCS-7	The information associated with a WO shall be kept for the life of the mission.
Ingest MOC Files	3.2.1.3.6	The IAS shall be capable of receiving telemetry trend reports, spacecraft status reports, and event schedules from the MOC.
	3.2.1.3.7	The IAS shall be capable of receiving Flight Dynamics Facility (FDF)-generated, definitive ephemeris from the MOC.
	3.2.2.7.1	The IAS shall generate calibration, data quality assessment, and problem reports.
	3.2.2.7.5	The IAS shall generate processing summaries after each IAS activity.
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
Ingest 0R Files	3.2.1.1.2	The IAS shall receive Level 0R data, Level 0R products, and associated ancillary data from the EDC DAAC.
	3.2.2.3.1	The IAS shall be capable of processing payload correction data (PCD) data to correct spacecraft time, generate a sensor pointing model (attitude and jitter), and calculate spacecraft position and velocity (ephemeris).
	3.2.2.4.12	The IAS shall be able to evaluate the quality of Level 0R products. Quality checks will include but not be limited to those listed in Table 3.2.2.4-1.
	3.2.2.4.12b	The IAS shall range check all but the housekeeping parameters in the L0R Product Payload Correction Data.
	3.2.2.4.12c	The IAS shall validate scan direction consistency in the L0R Product Mirror Scan Correction Data.
	3.2.2.4.12d	The IAS shall validate FHSERR/SHSERR consistency in the L0R

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
		Product Mirror Scan Correction Data.
	3.2.2.4.12e	The IAS shall validate counted line length consistency in the L0R Product Mirror Scan Correction Data.
	3.2.2.4.12g	The IAS shall validate the consistency of the applicability date in the Calibration Parameter File with the L0R Product image files.
	3.2.2.4.12h	The IAS shall validate the consistency of the Calibration Parameter File of the L0R Product with the IAS database.
	3.2.2.4.12j	The IAS shall validate scene coordinates from the L0R Product metadata.
	3.2.2.4.12k	The IAS shall validate file name consistency from the L0R Product metadata.
	3.2.2.4.12l	The IAS shall validate the correctness of WRS scene parameters from the L0R Product metadata.
	3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.
	3.2.2.7.1	The IAS shall generate calibration, data quality assessment, and problem reports.
	3.2.2.7.5	The IAS shall generate processing summaries after each IAS activity.
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
	3.2.4.8r	The IAS shall evaluate LPS data quality.
	3.2.4.8s	The IAS shall evaluate Level 0R data and products.
	3.2.4.8u	The IAS shall evaluate PCD quality.
	3.2.4.13	The IAS shall be capable of retrieving cross-calibration data of other sensors from the EDC DAAC.
	DMS-1	DMS shall extract and store individual files from the Level 0R Product.
	DMS-2	DMS shall maintain internal directories for storing intermediate products during WO process
Ingest L0R from Tape	DMS-1	DMS shall extract and store individual files from the Level 0R Product.
	DMS-2	DMS shall maintain internal directories for storing intermediate products during WO process
Resource Manager	3.2.2.6.2	The IAS shall be capable of archiving all software and databases used in operations.
	3.2.2.6.9	The IAS shall have the capability to write outputs to tape.
	3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.
	3.2.4.7	The IAS shall ensure backup of all on-line data and operations software.
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
	DMS-2	DMS shall maintain internal directories for storing intermediate products during WO process.
	DMS-3	DMS shall maintain a catalog of data by IAS.
	PCS-6	The IAS shall maintain the status of WOs.
	PCS-7	The information associated with a WO shall be kept for the life of the mission.

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
Analyst User Interface	3.2.2.4.12a	The IAS shall provide the capability to visually check L0R Product imagery.
	3.2.2.4.12I	The IAS shall support validation of ACCA scores from the L0R Product metadata through visual inspection of the associated L0R image files.
	3.2.2.4.13	The IAS shall be capable of performing a trend analysis over any desired time interval for each selected evaluation activity.
	3.2.2.4.15	The IAS shall provide the capability to visually inspect image data.
	3.2.2.4.16	The IAS shall provide a capability that allows an image analyst to monitor assessment processes and results.
	3.2.2.4.17	The IAS shall have the capability to review output data, including but not limited to calibration reports and updates.
	3.2.2.6.10	The IAS shall have the capability to generate hardcopy outputs.
	3.2.2.7.3	The IAS shall generate annual reports that document calibration coefficient and performance analysis trends.
	3.2.2.7.4	The IAS shall generate reports of anomaly detection analyses as they are concluded.
	3.2.3.17	The IAS shall generate monthly reports that document the quality of 0R data and 0R products retrieved from the EDC DAAC.
	3.2.3.18	The IAS shall provide regular calibration and performance updates to the EDC DAAC and other interfaces quarterly.
	3.2.3.19	The IAS shall provide an annual Landsat 7 image quality report.
	3.2.4.8r	The IAS shall evaluate LPS data quality.
	3.2.4.8 v	The IAS shall generate evaluation reports on a monthly, quarterly, and annual basis.
	3.2.4.8w	The IAS shall perform selected trend analyses.
	3.2.4.14	The IAS capability shall be used in performing anomaly assessment, resolution, and reporting.
	E&A -1	E&A shall provide the following capabilities for displaying WO inputs, intermediate results, and outputs:
	E&A-1.2	• Formated display of binary non-image system inputs and intermediate datasets
	E&A-3	E&A shall provide the capability to edit system input files, including image, PCD, MSCD, and CPFs in support of "what if" analyses. E&A shall provide editable forms and perform sanity checks of modifed parameters before accepting them.
	E&A-4	E&A shall provide a user interface to cusom IAS applications for radiometric and geometric assessment and evaluation. The Analyst and Operator interfaces shall have the same.
	PCS-1	The user shall be able to interactively enter or update a WO specifiying the processing to be performed.
	PCS-2	Both standard batch and "what if" processing shall be accommodated. The IAS shall segregate data generated during "what if" processing from that generated during standard batch processing.
	PCS-3	The IAS shall allow the Operator to assign priorities to WOs and shall execute WOs in priority sequence.
	PCS-4	The IAS shall provide the capability to generate and modify procedures

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
		specifying processing to perform.
	PCS-5	The IAS shall provide the capability to pause the execution of a WO at the predefined points and to continue the processing of a WO on user command.
	PCS-8	The information maintained with each WO shall include (but is not limited to) the following: • Unique WO ID • Date/time WO entered • Name of Requester • Type of request (e.g., standard, custom, test, etc.) • Image input file(s) • Date/time input file(s) requested • Date/time input file(s) received • Processing procedure to be performed on each file • Status of each processing step performed • Action prior to starting next step (e.g., pause for analysis) • Desired completion date • Date/time of completion WO • Current status of WO (e.g., in progress, complete, withdrawn, etc.) • WO priority
Operator User Interface	3.2.1.1.1	The IAS shall interface with the EDC DAAC for purposes of searching for and ordering of data from the Landsat 7 archive.
	3.2.1.3.1	The IAS shall send requests to the MOC for the operational acquisition of partial-aperture calibration data, full-aperture calibration data, and surface image data of radiometric and geometric calibration ground sites.
	3.2.1.3.3	The IAS shall send requests to the MOC for concentrated definitive ephemeris.
	3.2.1.3.4	The IAS shall send problem reports to the MOC.
	3.2.1.3.5	The IAS shall send calibration parameter files to the MOC.
	3.2.2.5.1	The IAS shall have the capability to acquire, develop, test, and add new algorithms and software to improve the radiometric and geometric properties of ETM+ data and their assessment without impacting IAS operations.
	3.2.2.5.3	The IAS shall have the capability to incorporate new algorithms into the operational system without impacting normal IAS operations.
	3.2.2.6.1	The IAS shall provide the capability to select the processing to be applied to data sets.
	3.2.2.6.3	The IAS shall be capable of storing selected data, parameters, ancillary data, reports, and documents.
	3.2.2.6.9	The IAS shall have the capability to write outputs to tape.
	3.2.2.6.10	The IAS shall have the capability to generate hardcopy outputs.
	3.2.2.6.12	The IAS shall allow the operator to select thresholds for results and errors reported by the IAS.
	3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.

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Task Name	Reqt No.	Requirement Statement
	3.2.3.15	The IAS shall be capable of receiving and storing 10 ETM+ Level 0R scene products or equivalent per day of data from the EDC DAAC.
	3.2.3.16	The IAS shall be capable of archiving test site image data (initial, intermediate, and final products), characterization data, calibration data, calibration parameter files, and reports, generated by the IAS, over the life of the mission.
	3.2.4.7	The IAS shall ensure backup of all on-line data and operations software.
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
	3.2.4.13	The IAS shall be capable of retrieving cross-calibration data of other sensors from the EDC DAAC.
	3.2.4.14	The IAS capability shall be used in performing anomaly assessment, resolution, and reporting.
	E&A-4	E&A shall provide a user interface to cusom IAS applications for radiometric and geometric assessment and evaluation. The Analyst and Operator interfaces shall have the same.
	PCS-1	The user shall be able to interactively enter or update a WO specifiying the processing to be performed.
	PCS-2	Both standard batch and “what if” processing shall be accommodated. The IAS shall segregate data generated during “what if” processing from that generated during standard batch processing.
	PCS-3	The IAS shall allow the Operator to assign priorities to WOs and shall execute WOs in priority sequence.
	PCS-4	The IAS shall provide the capability to generate and modify procedures specifying processing to perform.
	PCS-5	The IAS shall provide the capability to pause the execution of a WO at the predefined points and to continue the processing of a WO on user command.
	PCS-8	The information maintained with each WO shall include (but is not limited to) the following: • Unique WO ID • Date/time WO entered • Name of Requester • Type of request (e.g., standard, custom, test, etc.) • Image input file(s) • Date/time input file(s) requested • Date/time input file(s) received • Processing procedure to be performed on each file • Status of each processing step performed • Action prior to starting next step (e.g., pause for analysis) • Desired completion date • Date/time of completion WO • Current status of WO (e.g., in progress, complete, withdrawn, etc.) • WO priority
Editor (COT)	E&A -1	E&A shall provide the following capabilities for displaying WO inputs, intermediate results, and outputs:

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Task Name	Reqt No.	Requirement Statement
	E&A-1.1	• Display ASCII text reports from Run Log
ENVI (COT)	E&A -1	• E&A shall provide the following capabilities for displaying WO inputs, intermediate results, and outputs:
	E&A-1.3	• Color display of L0R and intermediate image datasets
	E&A-1.4	• Scrolling over entire image
	E&A-1.5	• Contrast stretch capability for individual line (detector), band or all bands displayed.
	E&A-1.6	• Windowing for multiple bands or multiple scenes
	E&A-1.7	• Color display of up to three overlaid bands of image data at resolution from sub-scene full resolution to HDF sub-sampletd resolution with capability of zooming between resolution levels.
	E&A-1.8	• Image mosaicing capability
	E&A-1.9	• Display of line/pixel coordinates and pixel values at designated cursor locations
	E&A-1.10	• Formatted dump of image datasets
	E&A-1.11	• Hardcopy print of image datasets
	E&A-2	E&A shall provide the following data analysis capabilities:
	E&A-2.1	• Pixel arithmetic functions for multiple band combinations
	E&A-2.2	• Histogram analysis
	E&A-2.3	• FFT analyis
	E&A-2.4	• Statistical analysis package
	E&A-3	E&A shall provide the capability to edit system input files, including image, PCD, MSCD, and CPFs in support of “what if” analyses. E&A shall provide editable forms and perform sanity checks of modifed parameters before accepting them.
Format Transmit Data	DMS-4	DMS shall communicate for data exchange with external systems.
	DMS-5	DMS shall extract Calibrated Parameter fields from the IAS database and formate the CPF for distribution to external systems.
Frame Maker (COT)	E&A-2	E&A shall provide the following data analysis capabilities:
	E&A-5	E&A shall provide the capability to generate reports summarizing ETM+ instructment and IAS system perfomance.
	E&A-6	E&A shall provide the capability to insert plots and other statistical measures output by E&A data analysis applications into an analyst-generated report.
Geometric Processing	3.2.2.2.1	The IAS shall be capable of determining the misalignment between the satellite navigational base reference and the ETM+ payload line-of-sight (LOS).
	3.2.2.2.2	The IAS shall be capable of determining band-to-band registration parameters.
	3.2.2.2.3	The IAS shall be capable of characterizing and updating along and across scan parameters (i.e., scan mirror profiles, scan-line corrector

Table A – 2 IAS Software Tasks to IAS System Requirements		
Task Name	**Reqt No.**	**Requirement Statement**
		mirror profile, detector offsets, detector delays).
	3.2.2.2.4	The IAS shall be capable of generating geometric calibration updates for the calibration parameter file.
	3.2.2.3.1	The IAS shall be capable of processing payload correction data (PCD) data to correct spacecraft time, generate a sensor pointing model (attitude and jitter), and calculate spacecraft position and velocity (ephe+meris).
	3.2.2.3.3	The IAS shall be capable of creating systematically corrected ETM+ Level 1G imagery from Level 0R products.
	3.2.2.3.4	The IAS shall be capable of creating precision corrected ETM+ Level 1G imagery from Level 0R products and ground control points (GCPs).
	3.2.2.3.5	The IAS shall be capable of creating terrain corrected ETM+ Level 1G imagery from Level 0R products, GCPs, and elevation data.
	3.2.2.3.6	The IAS shall be capable of performing image-to-image registration.
	3.2.2.3.7	The IAS shall be capable of incorporating IAS-generated calibration coefficient updates to generate Level 1 data.
	3.2.2.3.8	The IAS shall support nearest neighbor, cubic convolution, and modulation transfer function (MTF) compensation resampling.
	3.2.2.3.9	The IAS shall have the capability to produce a 1G product with a grid cell size that is variable from 15 to 60 meters, in increments of 1 millimeter (mm).
	3.2.2.3.10	The IAS shall have the capability to map project 1G using the Space Oblique Mercator, Universal Transverse Mercator, Lambert Conformal Conic, Transverse Mercator, Oblique Mercator, and Polyconic coordinate reference systems.
	3.2.2.3.11	The IAS shall have the capability to create a 1G image oriented to nominal path or north-up.
	3.2.2.3.12	The IAS shall be capable of processing Mirror Scan Correction Data (MSCD) to generate scan mirror and scan line corrector mirror models
	3.2.2.3.13	The IAS shall be capable of compensating for inoperable and saturated detectors during Level 1R and 1G processing.
	3.2.2.3.14	The IAS shall be capable of compensating for the image artifacts of striping, banding, coherent noise, memory effect, and scan correlated shift in Level 1R and 1G processing.
	3.2.2.3.15	The IAS shall be capable of processing to Level 1R and 1G both ascending and descending pass ETM+ Level 0R data.
	3.2.2.4.2	The IAS shall be able to evaluate the absolute radiometric accuracy of ETM+ Level 0R, 1R, and 1G data.
	3.2.2.4.8	The IAS shall be able to evaluate the geodetic accuracy of ETM+ Level 1G image data.
	3.2.2.4.9	The IAS shall be able to evaluate the internal geometric accuracy of ETM+ Level 1G image data
	3.2.2.4.10	The IAS shall be able to evaluate the band-to-band registration accuracy of ETM+ imagery.

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
	3.2.2.4.11	The IAS shall be able to evaluate the image-to-image registration accuracy of ETM+ data.
	3.2.2.6.5	The IAS shall be capable of storing selected GCPs and GCP chips.
	3.2.2.6.6	The IAS shall be capable of storing selected digital elevation models (DEMs).
	3.2.2.6.11	The IAS shall archive selected prelaunch data, including but not limited to sensor engineering, ETM+ image data, alignment matrices, calibration measurements, mirror scan profiles, FASC bi-directional reflectance distribution function (BRDF), etc.
	3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.
	3.2.2.7.1	The IAS shall generate calibration, data quality assessment, and problem reports.
	3.2.3.3	The IAS shall contribute no greater than 0.7 percent uncertainty to absolute radiometric accuracy during the generation of Level 1R and 1G data.
	3.2.3.4	The IAS shall be able to create systematic imagery to a geodetic accuracy of 250 meters, 1 sigma, providing all inputs are within specification. Performance applies to along-track and cross-track directions and is referenced to a nadir-viewing geometry.
	3.2.3.5	The IAS shall contribute circular errors no greater than 1.8 meters, 1 sigma, in the production of systematically corrected ETM+ Level 1G imagery. This error is referenced to a nadir-viewing geometry and excludes the effect of terrain correction.
	3.2.3.6	The IAS shall provide the capability to register pixels from a band to the corresponding pixels of the other bands in a common scene to an accuracy of 0.28 sensor guide star data (GSD), 0.9p, in along-track and cross-track directions, providing all inputs
	3.2.3.7	The IAS shall contribute error no greater than 0.11 multispectral sensor GSD, 0.9p, along-track, and 0.24 multispectral sensor GSD, 0.9p, cross-track, in the assessment of band-to-band registration.
	3.2.3.8	The IAS shall provide the capability to perform image-to-image registration to an accuracy of 0.4 multispectral sensor GSD, 0.9p, in the along-track and cross-track directions providing all inputs are within specification.
	3.2.3.9	The IAS shall contribute circular errors no greater than 3.6 meters, 1 sigma, during image-to-image registration correction of ETM+ Level 1G data. Error is referenced to a nadir-viewing geometry and excludes the effect of terrain correction.
	3.2.3.10	The IAS shall be capable of estimating the field angles to an accuracy of 0.18 arcsec, 1 sigma.
	3.2.3.11	The IAS shall be capable of digitally correlating common features in separate bands of the same image or same bands of separate images to an accuracy of 0.1 pixel, 0.9p.

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
	3.2.3.12	The IAS shall be capable of estimating the alignment of the ETM+ line-of-sight to the satellite navigation base reference to an accuracy of 24 arcsec, 1 sigma, in all axes.
	3.2.3.21	The IAS shall be capable of storing 68 megabytes (MB) of GCP data (points, chips, metadata).
	3.2.3.22	The IAS shall capable of storing 20 GB of elevation data.
	3.2.4.8a	The IAS shall perform sensor alignment calibrations calibrations.
	3.2.4.8b	The IAS shall perform band-to-band registrations.
	3.2.4.8c	The IAS shall perform detector delay calibrations.
	3.2.4.8e	The IAS shall generate calibration reports quarterly.
	3.2.4.8l	The IAS shall perform geodetic accuracy assessments.
	3.2.4.8m	The IAS shall perform geometric accuracy assessments.
	3.2.4.8n	The IAS shall perform Band-to-band registration accuracy.
	3.2.4.8o	The IAS shall perform Image-to-image registration accuracy.
	3.2.4.8r	The IAS shall evaluate LPS data quality.
	3.2.4.8s	The IAS shall evaluate Level 0R data and products.
	3.2.4.8u	The IAS shall evaluate PCD quality.
	E&A-2	E&A shall provide the following data analysis capabilities:
	E&A-2.9	• Control Point coorelation capability
Perform Trending Analysis	E&A-2	E&A shall provide the following data analysis capabilities:
	E&A-2.5	• Trending of selected parameters, including regression/curve fitting with measures of quality fit
	E&A-2.6	• Canned trending scripts for standard trending plots
	E&A-2.7	• 1D, 2D, and 3D plotting capability, including scatter plots, line plots, image displays, contour, wireframe and shaded-surface displays.
	E&A-2.8	• Screen display of all plots/reports
RPS/GPS WO Script	PCS-2	Both standard batch and “what if” processing shall be accommodated. The IAS shall segregate data generated during “what if” processing from that generated during standard batch processing.
	PCS-5	The IAS shall provide the capability to pause the execution of a WO at the predefined points and to continue the processing of a WO on user command.
View L0R Ingest Report	E&A -1	E&A shall provide the following capabilities for displaying WO inputs, intermediate results, and outputs:
	E&A-1.2	• Formated display of binary non-image system inputs and intermediate datasets
	E&A -1	E&A shall provide the following capabilities for displaying WO inputs, intermediate results, and outputs:
	E&A-1.2	• Formated display of binary non-image system inputs and intermediate datasets
	E&A-1.2	• Formated display of binary non-image system inputs and

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
		intermediate datasets
L0R Characterization and Correction (r0r)	3.2.2.1.1	The IAS shall be able to use data from the internal calibrator in the calibration of the radiometric response of each ETM+ detector.
	3.2.2.1.4	The IAS shall be able to calibrate the radiometric response of each ETM+ detector given Level 0R data of a ground calibration site and corresponding at-aperture spectral radiance values.
	3.2.2.1.5	The IAS shall be able to calibrate the radiometric response of each ETM+ detector using Level 0R data from preship and prelaunch calibration sources and auxiliary calibration source data.
	3.2.2.1.6	The IAS shall have the capability of assessing the short-term and long-term stability of the onboard calibration sources, which include the FASC, the PASC, and the internal calibrators.
	3.2.2.1.7	The IAS shall be able to integrate the results of the various calibration processes into an optimal estimate of radiometric calibration of each detector (except band 6) and provide new calibration parameters.
	3.2.2.1.8	The IAS shall be capable of generating radiometric calibration updates for the calibration parameter file.
	3.2.2.1.9	The IAS shall be able to transfer the calibration of each detector to the internal calibrator.
	3.2.2.3.2	The IAS shall be capable of processing ETM+ Level 0R products to produce radiometrically corrected Level 1R image data.
	3.2.2.3.3	The IAS shall be capable of creating systematically corrected ETM+ Level 1G imagery from Level 0R products.
	3.2.2.3.4	The IAS shall be capable of creating precision corrected ETM+ Level 1G imagery from Level 0R products and ground control points (GCPs).
	3.2.2.3.5	The IAS shall be capable of creating terrain corrected ETM+ Level 1G imagery from Level 0R products, GCPs, and elevation data.
	3.2.2.4.2	The IAS shall be able to evaluate the absolute radiometric accuracy of ETM+ Level 0R, 1R, and 1G data.
	3.2.2.4.3	The IAS shall be able to assess the identified ETM+ radiometric image artifacts of striping; banding; random, correlated, and coherent noise; memory effect; and scan-correlated shift.
	3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.
	3.2.2.7.5	The IAS shall generate processing summaries after each IAS activity.
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
	3.2.4.8s	• The IAS shall evaluate Level 0R data and products.
L0Rc Characterization and Correction (r0c)	3.2.2.1.1	The IAS shall be able to use data from the internal calibrator in the calibration of the radiometric response of each ETM+ detector.
	3.2.2.1.2	The IAS shall be able to calibrate the radiometric response of each ETM+ detector, except band 6, using data from the partial-aperture solar calibrator (PASC).

Table A – 2 IAS Software Tasks to IAS System Requirements		
Task Name	**Reqt No.**	**Requirement Statement**
	3.2.2.1.3	The IAS shall be able to calibrate the radiometric response of each ETM+ detector, except band 6, using data from the full-aperture solar calibrator (FASC).
	3.2.2.1.4	The IAS shall be able to calibrate the radiometric response of each ETM+ detector given Level 0R data of a ground calibration site and corresponding at-aperture spectral radiance values.
	3.2.2.1.5	The IAS shall be able to calibrate the radiometric response of each ETM+ detector using Level 0R data from preship and prelaunch calibration sources and auxiliary calibration source data.
	3.2.2.1.6	The IAS shall have the capability of assessing the short-term and long-term stability of the onboard calibration sources, which include the FASC, the PASC, and the internal calibrators.
	3.2.2.1.7	The IAS shall be able to integrate the results of the various calibration processes into an optimal estimate of radiometric calibration of each detector (except band 6) and provide new calibration parameters.
	3.2.2.3.2	The IAS shall be capable of processing ETM+ Level 0R products to produce radiometrically corrected Level 1R image data.
	3.2.2.3.3	The IAS shall be capable of creating systematically corrected ETM+ Level 1G imagery from Level 0R products.
	3.2.2.3.4	The IAS shall be capable of creating precision corrected ETM+ Level 1G imagery from Level 0R products and ground control points (GCPs).
	3.2.2.3.5	The IAS shall be capable of creating terrain corrected ETM+ Level 1G imagery from Level 0R products, GCPs, and elevation data.
	3.2.2.4.2	The IAS shall be able to evaluate the absolute radiometric accuracy of ETM+ Level 0R, 1R, and 1G data.
	3.2.2.4.12	The IAS shall be able to evaluate the quality of Level 0R products. Quality checks will include but not be limited to those listed in Table 3.2.2.4-1.
	3.2.2.4.12f	The IAS shall validate dropped line locations in the L0R Product Mirror Scan Correction Data.
	3.2.2.4.12m	The IAS shall validate calibration outliers in the L0R Product Calibration Pulse/Shutter data.
	3.2.2.4.12n	The IAS shall validate shutter means in the L0R Product Calibration Pulse/Shutter data.
	3.2.2.4.12o	The IAS shall validate shutter standard deviations in the L0R Product Calibration Pulse/Shutter data.
	3.2.2.4.12p	The IAS shall validate shutter outliers in the L0R Product Calibration Pulse/Shutter data.
	3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.
	3.2.2.7.5	The IAS shall generate processing summaries after each IAS activity.
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
	3.2.4.8s	• The IAS shall evaluate Level 0R data and products.
L1R	3.2.2.1.2	The IAS shall be able to calibrate the radiometric response of each

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
Characterization and Correction (r1r)		ETM+ detector, except band 6, using data from the partial-aperture solar calibrator (PASC).
	3.2.2.1.3	The IAS shall be able to calibrate the radiometric response of each ETM+ detector, except band 6, using data from the full-aperture solar calibrator (FASC).
	3.2.2.1.7	The IAS shall be able to integrate the results of the various calibration processes into an optimal estimate of radiometric calibration of each detector (except band 6) and provide new calibration parameters.
	3.2.2.3.2	The IAS shall be capable of processing ETM+ Level 0R products to produce radiometrically corrected Level 1R image data.
	3.2.2.3.7	The IAS shall be capable of incorporating IAS-generated calibration coefficient updates to generate Level 1 data.
	3.2.2.3.13	The IAS shall be capable of compensating for inoperable and saturated detectors during Level 1R and 1G processing.
	3.2.2.3.14	The IAS shall be capable of compensating for the image artifacts of striping, banding, coherent noise, memory effect, and scan correlated shift in Level 1R and 1G processing.
	3.2.2.3.15	The IAS shall be capable of processing to Level 1R and 1G both ascending and descending pass ETM+ Level 0R data.
	3.2.2.4.1	The IAS shall evaluate the on-orbit operability of ETM+ detectors.
	3.2.2.4.2	The IAS shall be able to evaluate the absolute radiometric accuracy of ETM+ Level 0R, 1R, and 1G data.
	3.2.2.4.4	The IAS shall be able to evaluate the MTF of each ETM+ detector.
	3.2.2.4.5	The IAS shall be able to evaluate the signal-to-noise ratio (SNR) of each ETM+ detector, using prelaunch and on-orbit image data.
	3.2.2.4.6	The IAS shall be capable of evaluating the on-orbit radiometric response of each ETM+ detector with respect to dynamic range.
	3.2.2.4.7	The IAS shall be capable of evaluating the on-orbit radiometric response of each ETM+ detector, excluding band 6, with respect to linearity (TBD).
	3.2.2.4.12	The IAS shall be able to evaluate the quality of Level 0R products. Quality checks will include but not be limited to those listed in Table 3.2.2.4-1.
	3.2.2.4.12f	The IAS shall validate dropped line locations in the L0R Product Mirror Scan Correction Data.
	3.2.2.4.12m	The IAS shall validate calibration outliers in the L0R Product Calibration Pulse/Shutter data.
	3.2.2.4.12n	The IAS shall validate shutter means in the L0R Product Calibration Pulse/Shutter data.
	3.2.2.4.12o	The IAS shall validate shutter standard deviations in the L0R Product Calibration Pulse/Shutter data.
	3.2.2.4.12p	The IAS shall validate shutter outliers in the L0R Product Calibration Pulse/Shutter data.
	3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.
	3.2.2.7.5	The IAS shall generate processing summaries after each IAS activity.

Table A – 2 IAS Software Tasks to IAS System Requirements

Task Name	Reqt No.	Requirement Statement
	3.2.3.1	The IAS shall be capable of calibrating the radiometric response (absolute spectral radiance) of each operable ETM+ detector to an accuracy of 5 percent, 1 sigma, providing all inputs are within specification.
	3.2.3.2	The IAS shall be capable of calibrating the relative radiometric response such that the ratio of ETM+ equivalent at-aperture radiances between any combination of two spectral bands, excluding band 6, shall vary less than 2 percent, 1 sigma, over a 7-day p
	3.2.3.3	The IAS shall contribute no greater than 0.7 percent uncertainty to absolute radiometric accuracy during the generation of Level 1R and 1G data.
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
	3.2.4.8d	• The IAS shall perform radiometric calibrations.
	3.2.4.8f	• The IAS shall perform detector operability assessments.
	3.2.4.8g	• The IAS shall perform radiometric accuracy assessments.
	3.2.4.8h	• The IAS shall perform streaking and banding assessments.
	3.2.4.8i	• The IAS shall perform correlated and coherent noise assessments.
	3.2.4.8j	• The IAS shall perform MTF assessments.
	3.2.4.8k	• The IAS shall perform SNR assessments.
	3.2.4.8p	• The IAS shall perform Image artifact assessments.
	3.2.4.8t	• The IAS shall evaluate Level 1R data quality.
CRaM	3.2.2.6.8	The IAS shall be capable of storing solar spectral and broadband radiance data.
	3.2.2.6.11	The IAS shall archive selected prelaunch data, including but not limited to sensor engineering, ETM+ image data, alignment matrices, calibration measurements, mirror scan profiles, FASC bi-directional reflectance distribution function (BRDF), etc.
	3.2.2.6.13	The IAS shall automatically generate messages and alarms to alert the operator to IAS results and errors that exceed selected thresholds.
	3.2.2.7.1	The IAS shall generate calibration, data quality assessment, and problem reports.
	3.2.2.7.5	The IAS shall generate processing summaries after each IAS activity.
	3.2.4.8	The IAS shall perform calibrations, assessments, and evaluations with frequencies specified in Tables 3.2.4-1 and 3.2.4-2.
	3.2.4.8e	• The IAS shall generate calibration reports quarterly.
	3.2.4.8q	• The IAS shall generate assessment reports quarterly.
	3.2.4.8t	• The IAS shall evaluate Level 1R data quality.

Appendix B. IAS Software Size Estimates.

B.1 IAS Estimates Lines of Code

Table B-1 presents delivered source instructions (DSI) estimates for IAS software based on a detailed design of five IAS subsystems into software modules including the database and global routines. The software DSI estimates are based on a flat 100 DSI per module with 25% overhead to account for error handling. For 37 user interface modules, the estimate is at 100 DSI per module to account for reduce effort due to the use of the Oracle GUI building tool. In addition, a minimum of 500 DSIs have been added to each subsystem for analysis tools and test software. No software size reduction factor has been applied at this time to account for the re-use of any software building blocks available from other projects.

Table B-1. DSI Estimates for IAS Software at Preliminary Design

IAS Software Subsystem	No. of Tasks	No of Modules	Estimated DSI
Process Control Subsystem	3	14	1,750
Data Management Subsystem	7	70	8,7500
Radiometric Processing Subsystem	–	–	24,000
Geometric Processing Subsystem	–	–	35,050
Evaluation and Assessment Subsystem	8	49	6,125
User Interface	–	37	3,700
Database	–	–	7,500
Global Routines	–	24	3,000
Analysis Tools†	–	3	1,500
Test / Diagnostics†	–	3	1,500
Total			**92,875**

† A minimum of 500 DSIs each are assumed for database, analysis tools and test / diagnostic software for each IAS subsystem.

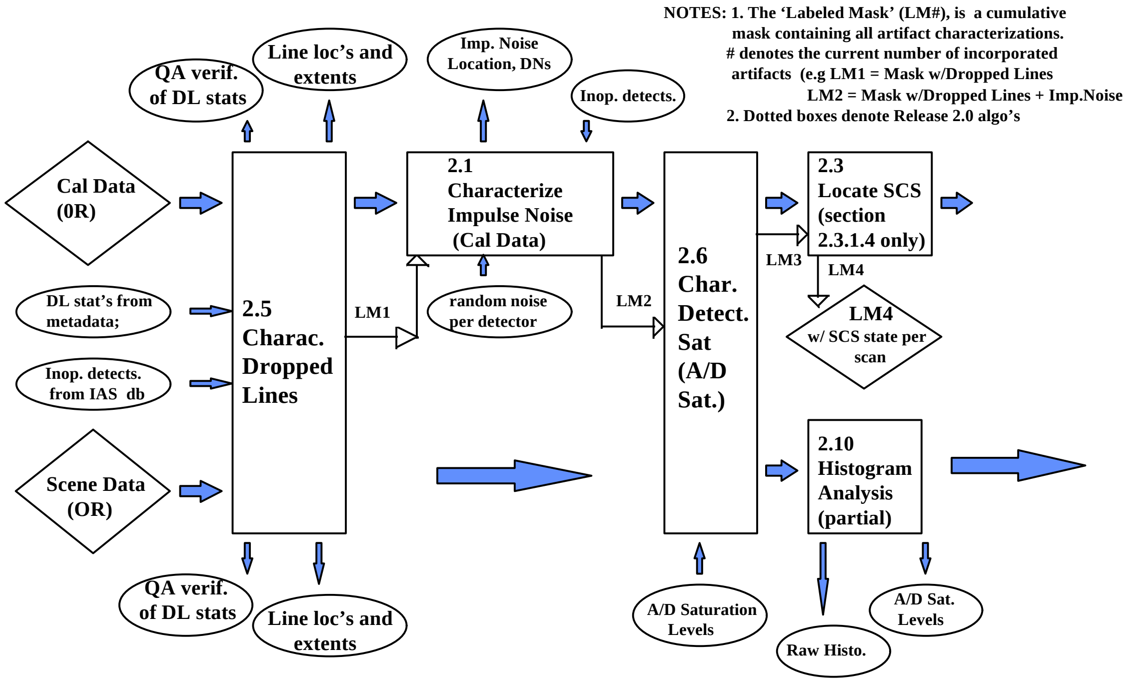
Appendix C. Radiometric Algorithms.

This Appendix presents the fixed sequences for the execution of the Radiometric algorithms. The included sequences are:

- Level 1R Processing (Day Scene)
- Process Night Scene
- Process PASC
- Process FASC

REVIEW

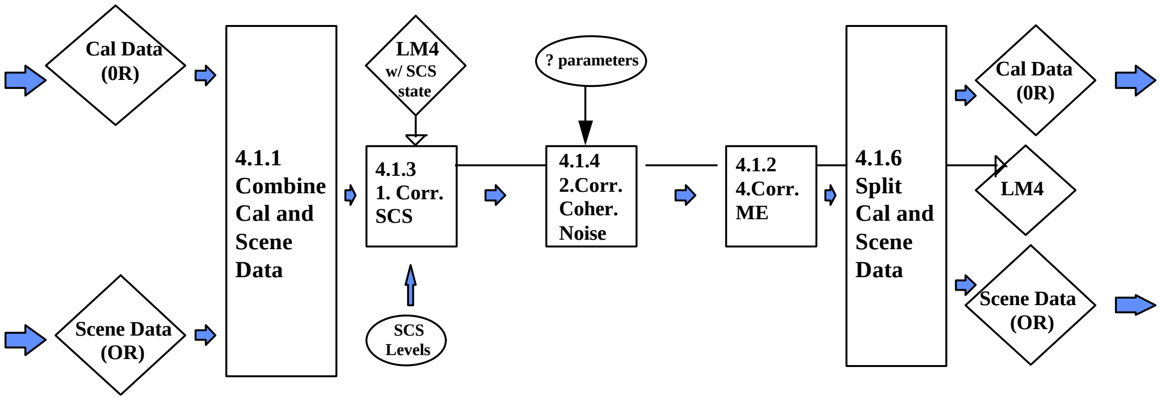
REVIEW



Level 1R Processing (Day Scene)
Release 1.0
Step 1. 0R Radiometric Characterization

(update 11/29/96)

REVIEW

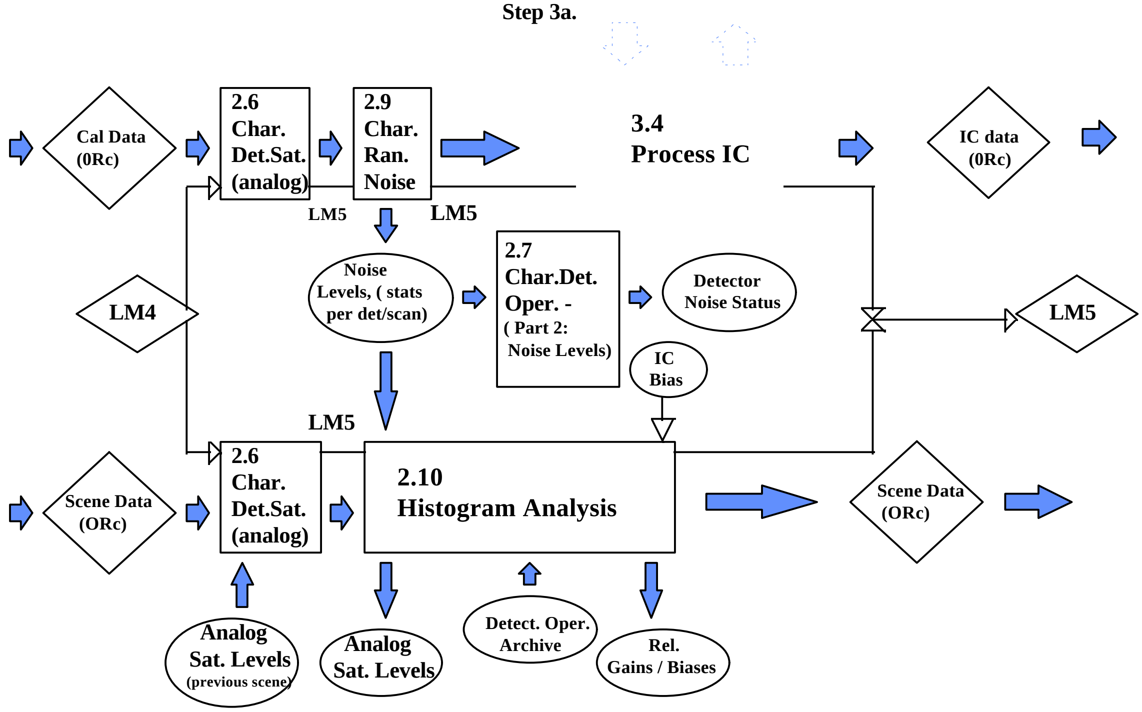


Note: Dotted boxes denote Release 2.0 algorithms

Level 1R Processing (Day Scene)
Release 1.0
Step 2. Pre-1R Correction
(revised11/29/96 ssj)

REVIEW

Notes: 1. Dotted boxes denote Release 2.0 algo's
2. For algorithm "3.4 Process IC", see detailed flow in
Step 3a.

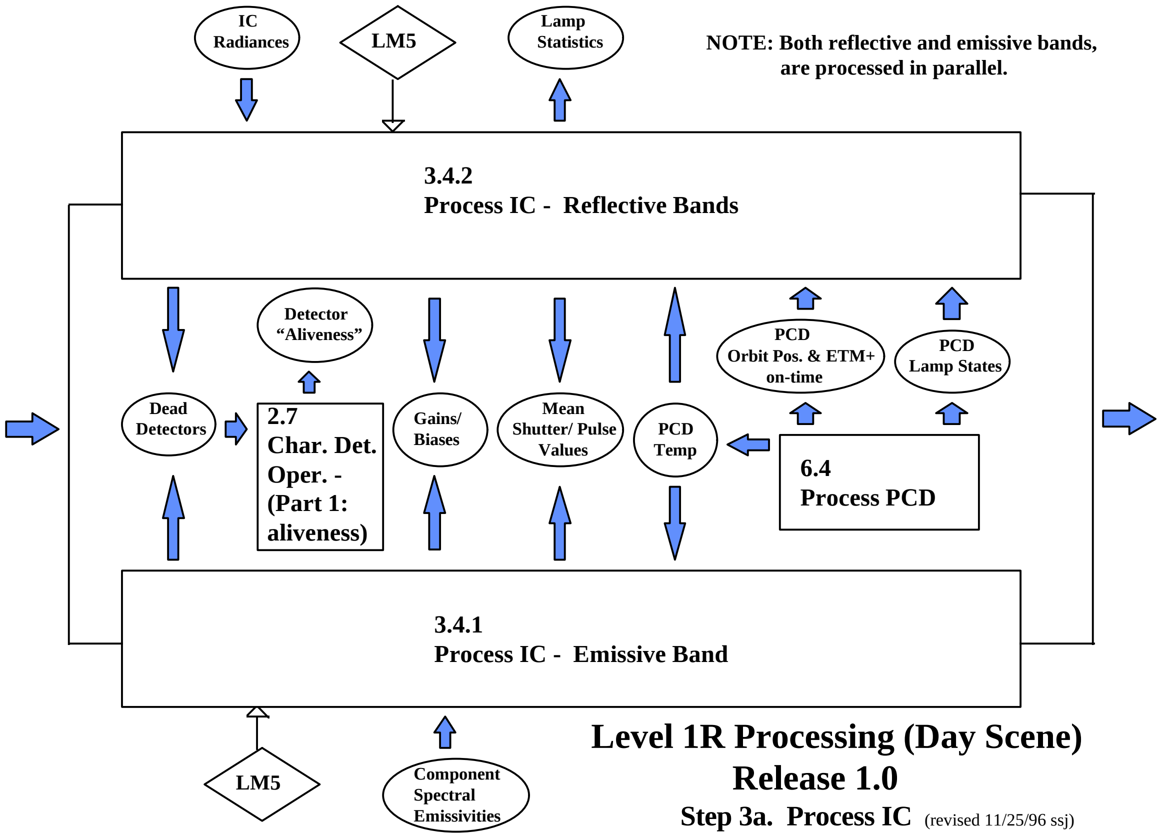


Level 1R Processing (Day Scene)
Release 1.0

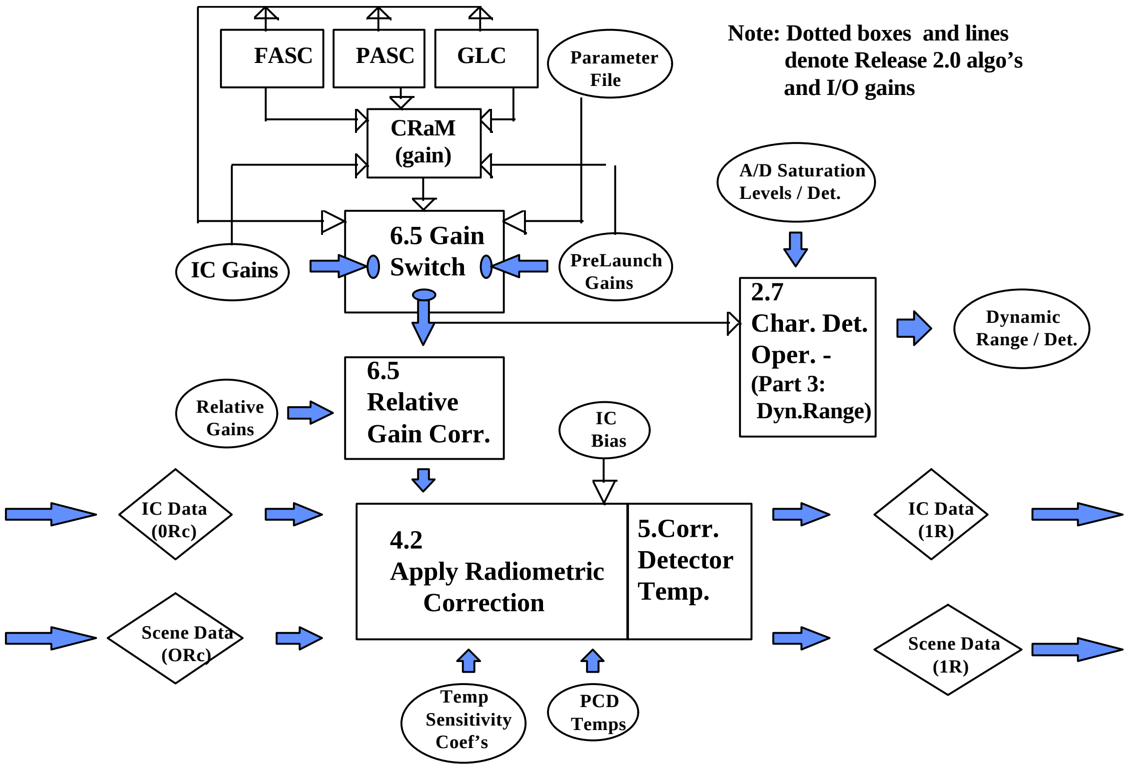
Step 3. ORc Radiometric Characterization/Calibration

(revised 11/25/96 ssj)

REVIEW


IC Radiances
LM5
Lamp Statistics
NOTE: Both reflective and emissive bands, are processed in parallel.
3.4.2
Process IC - Reflective Bands
Detector "Aliveness"
PCD Orbit Pos. & ETM+ on-time
PCD Lamp States
Dead Detectors
2.7 Char. Det. Oper. - (Part 1: aliveness)
Gains/ Biases
Mean Shutter/ Pulse Values
PCD Temp
6.4 Process PCD
3.4.1
Process IC - Emissive Band
LM5
Component Spectral Emissivities
Level 1R Processing (Day Scene)
Release 1.0
Step 3a. Process IC (revised 11/25/96 ssj)

REVIEW

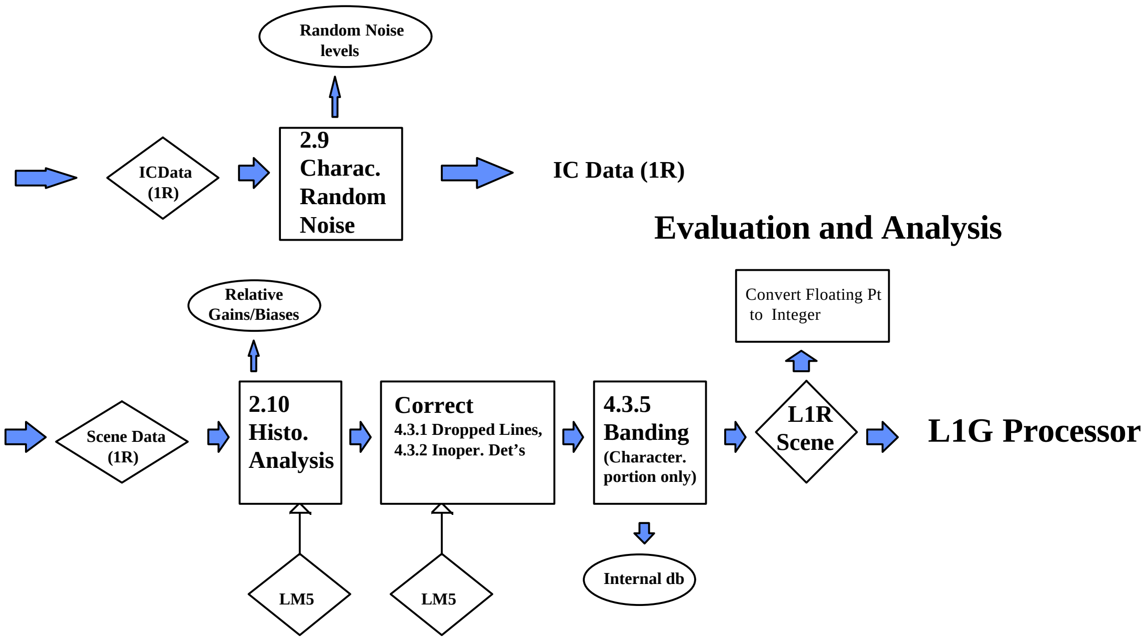


Level 1R Processing (Day Scene)
Release 1.0

Step 4. 1R Correction

(revised 9/11)

REVIEW



Level 1R Processing (Day Scene)

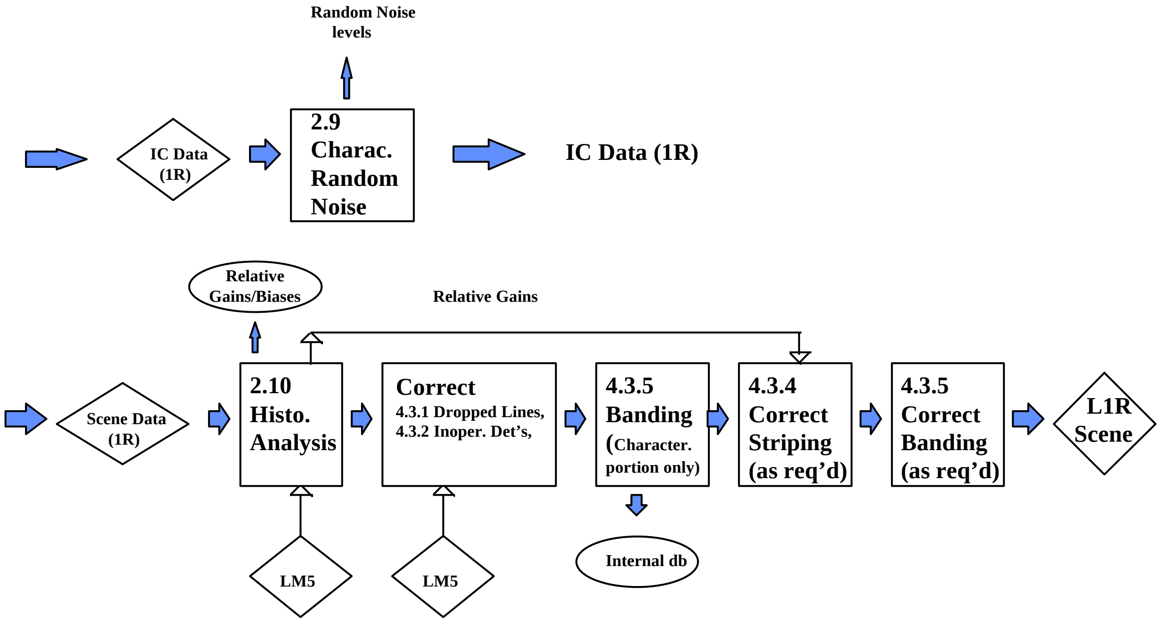
Release 1.0

Step 5.0 1R Radiometric Characterization/Correction

(Scenario 1: No Correction for Striping and Banding Effects)

(revised11/25/96)

REVIEW



Level 1R Processing (Day Scene)

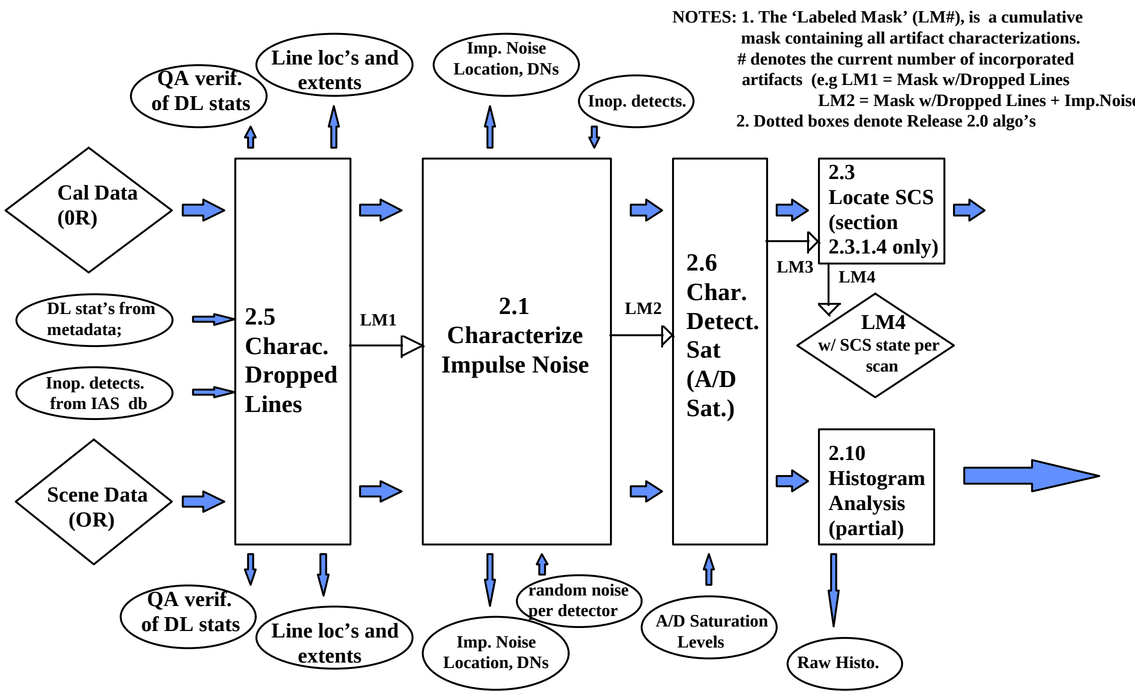
Release 1.0

Step 5.0 1R Radiometric Characterization/Correction

(Scenario 2: Correct for Striping and Banding Effects IFF Necessary)

(revised 11/25/96 ssj)

REVIEW



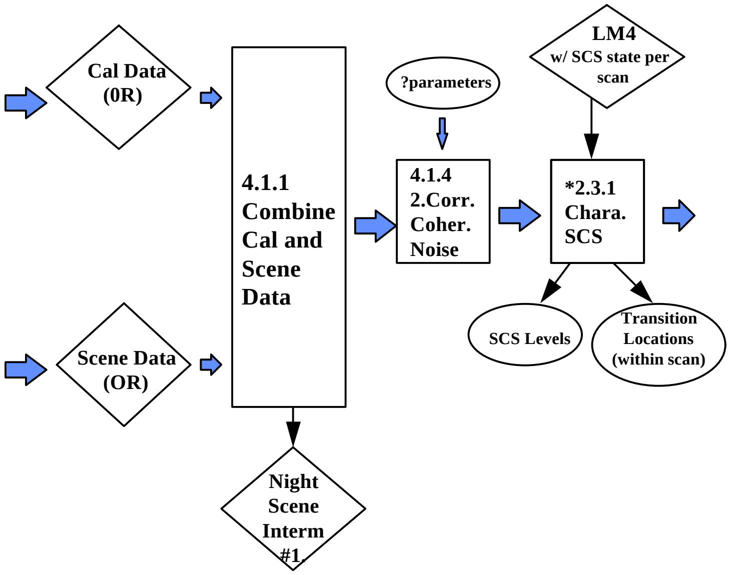
Process Night Scene

Step 1. 0R Radiometric Characterization

(update 11/29/96 ssj)

REVIEW

*** Not in Standard 1R processing**

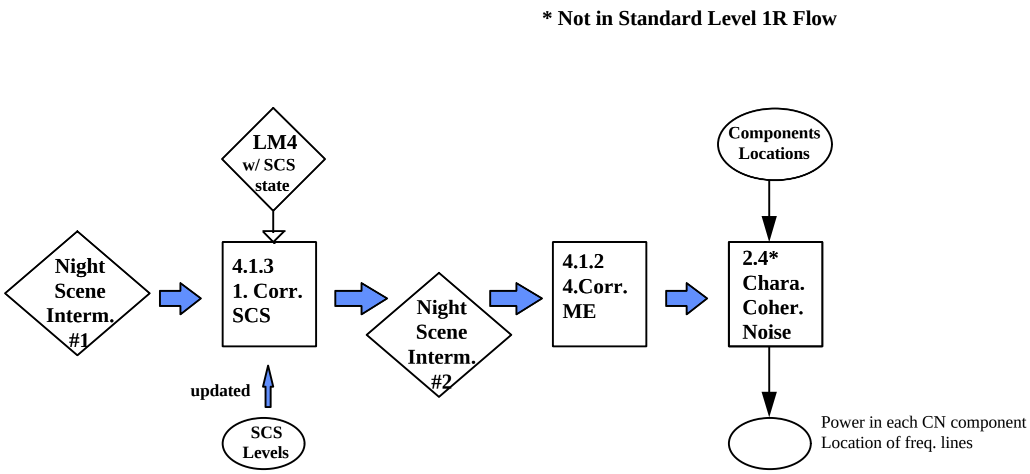


Process Night Scene

Step 2. Scan Correlated Shift Characterization

(revised 11/29/96 ssj)

REVIEW

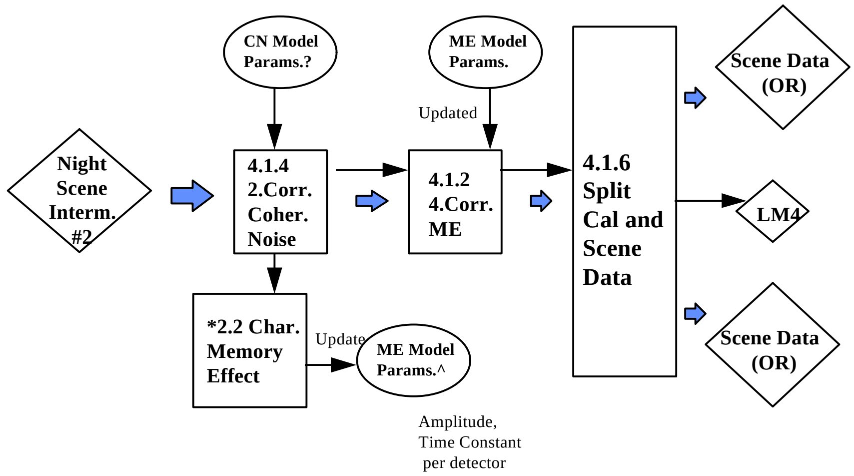


Process Night Scene

Step 3. Coherent Noise Characterization

(revised 11/29/96 ssj)

REVIEW



*** Not in Standard Level 1R Flow**
^ Saved separately by source (i.e. FASC, PASC, Night)

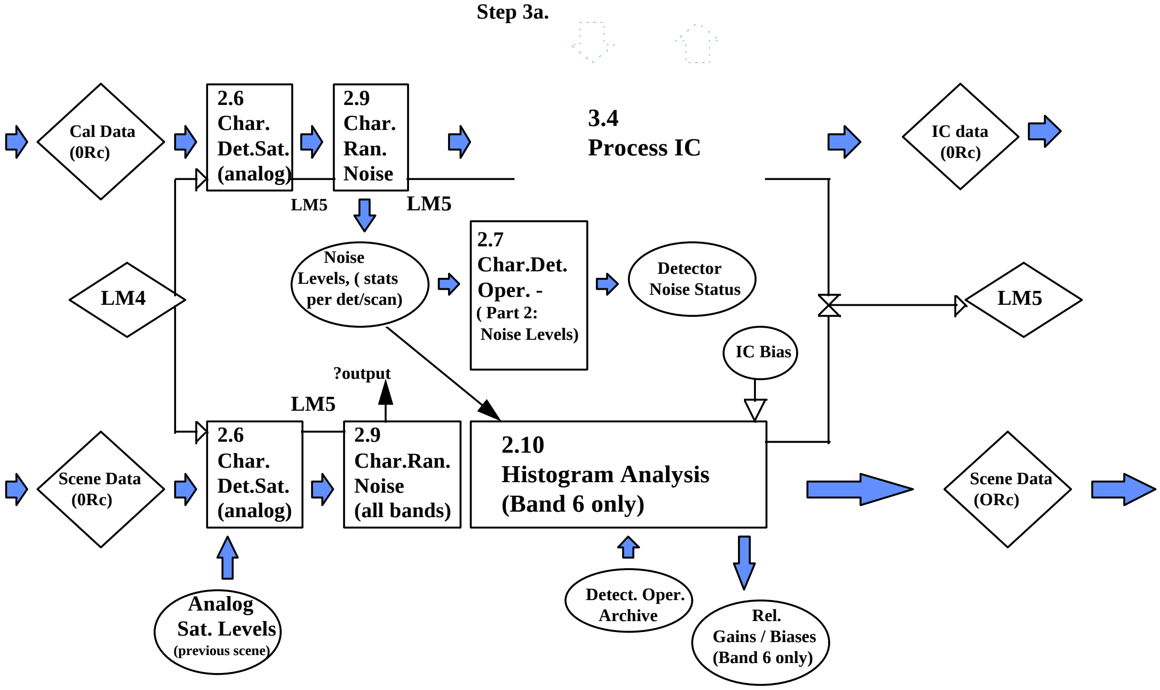
Process Night Scene

Step 4. Memory Effect Characterization

(revised 11/29/96 ssj)

REVIEW

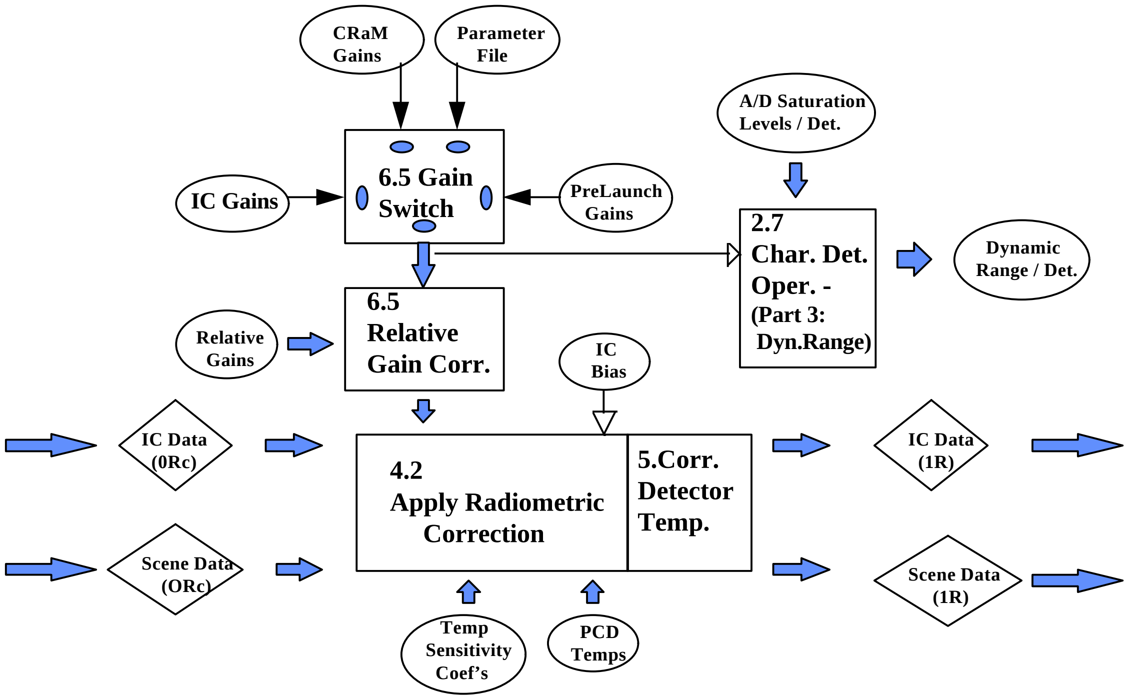
Notes: 1. Dotted boxes denote Release 2.0 algo's
2. For algorithm "3.4 Process IC", see detailed flow in Step 3a.



Processing Night Scene

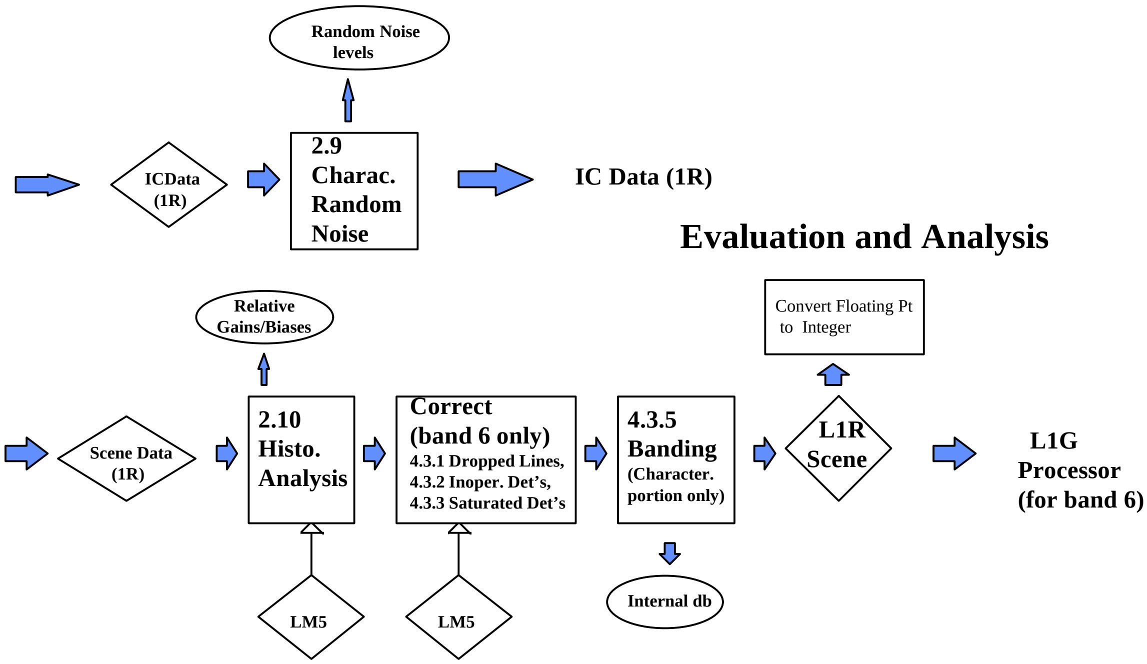
Step 5. 0Rc Radiometric Characterization/Calibration

(revised 11/29/96 ssj)



Process Night Scene
Step 6. 1R Correction
(revised 11/25/96 ssj)

REVIEW



Process Night Scene

Step 7. 1R Radiometric Characterization/Correction

(revised11/29/96 ssj)

REVIEW

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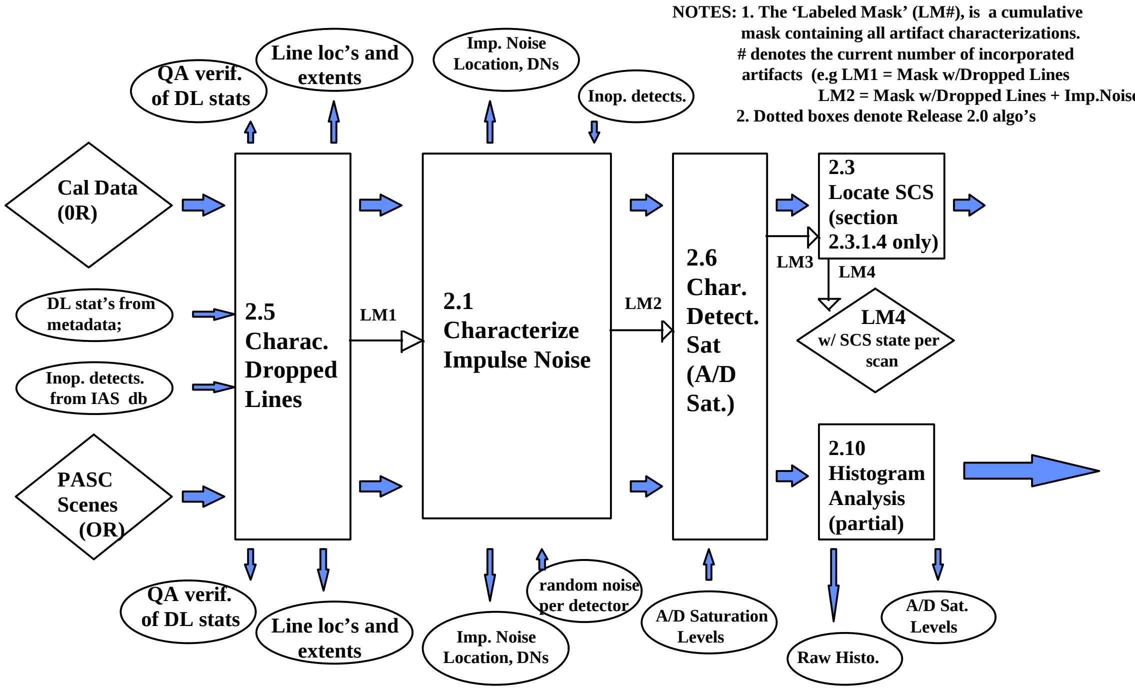
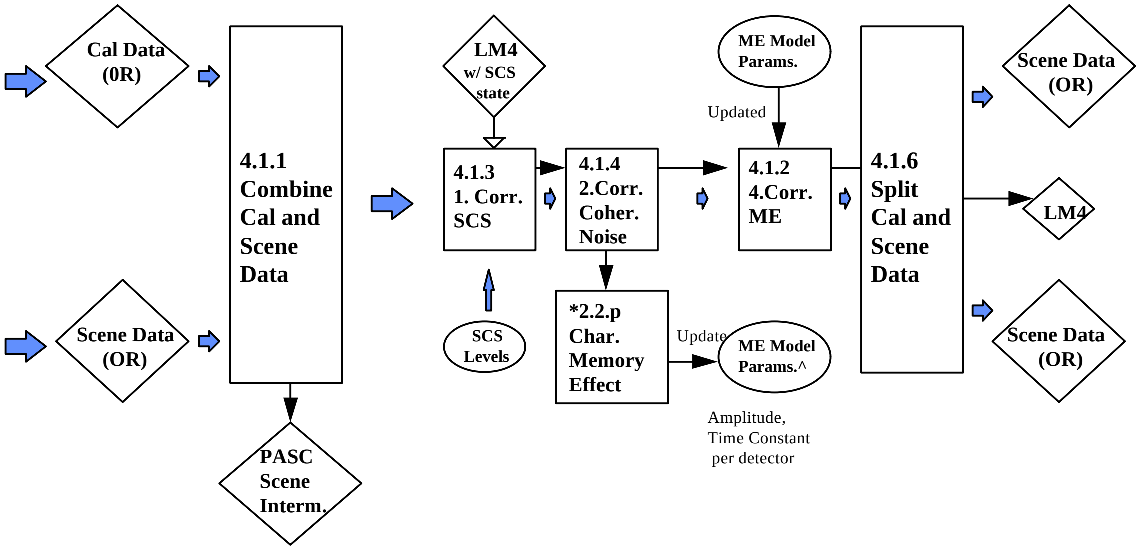


Process PASC

Step 1. 0R Radiometric Characterization

(update 11/29/96 ssj)

REVIEW



*** Not in Standard Level 1R Flow**
2.2.p algorithm applies to PASC only
^ saved by source (night, PASC, or FASC

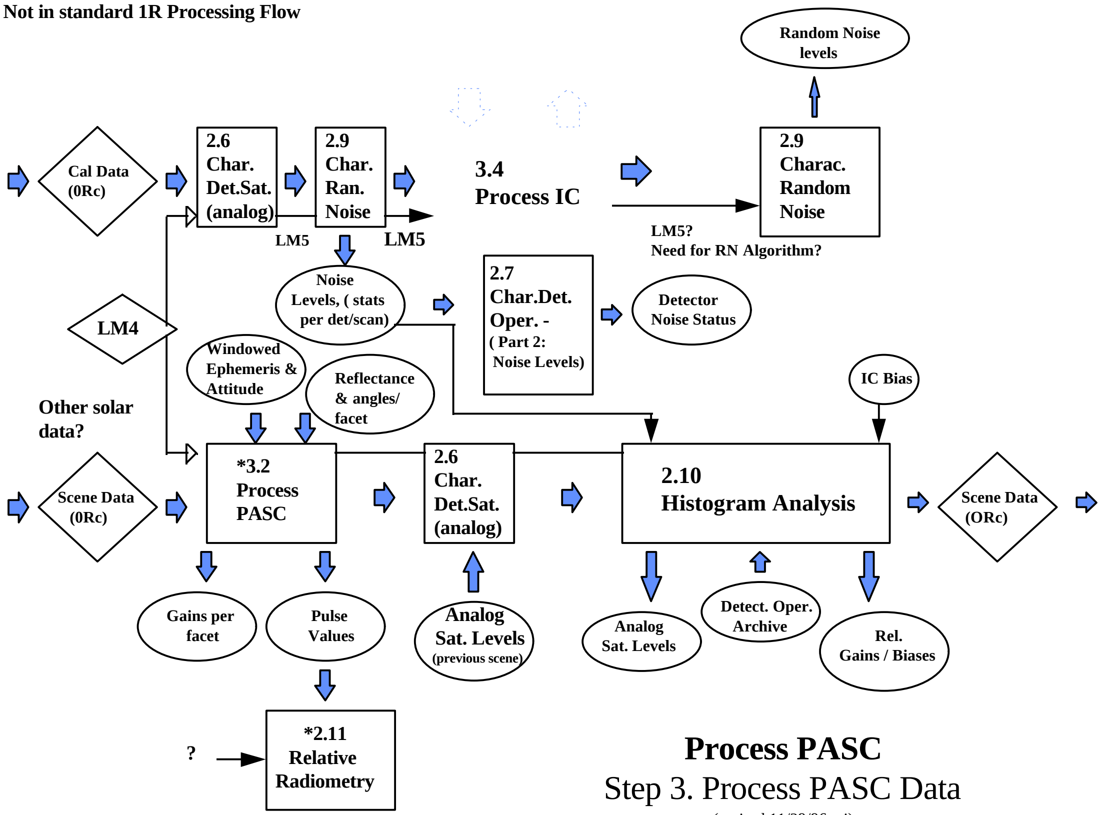
Process PASC

Step 2. Memory Effect Characterization

(revised 11/29/96 ssj)

REVIEW

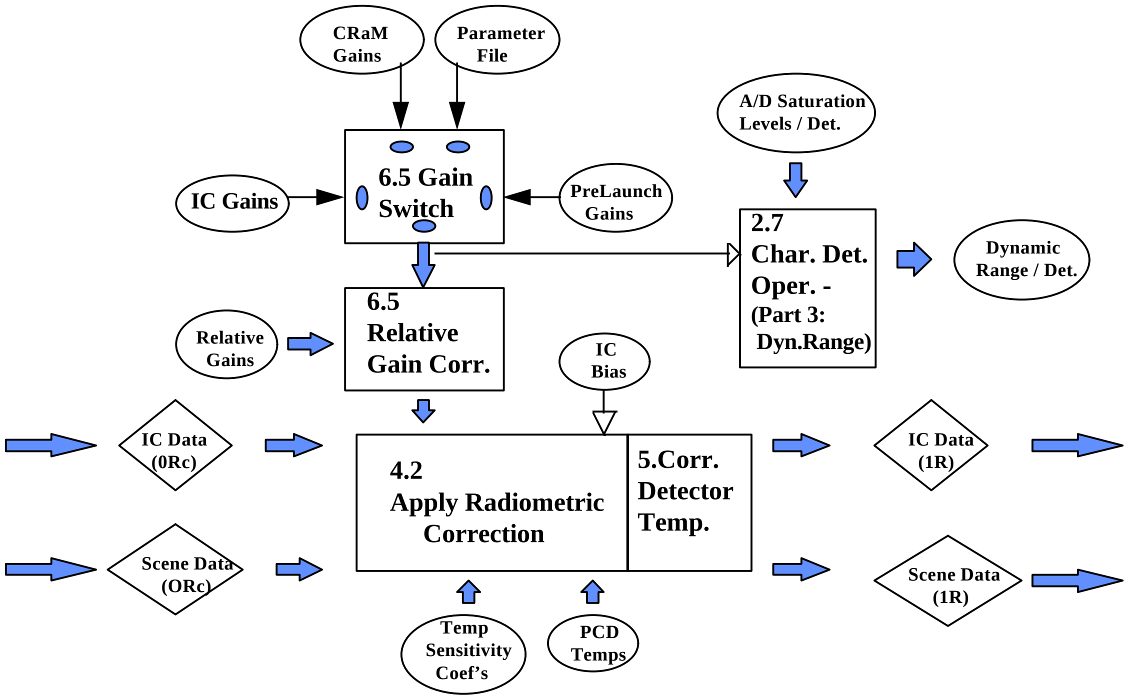
* Not in standard 1R Processing Flow



Process PASC

Step 3. Process PASC Data

(revised 11/29/96 ssj)

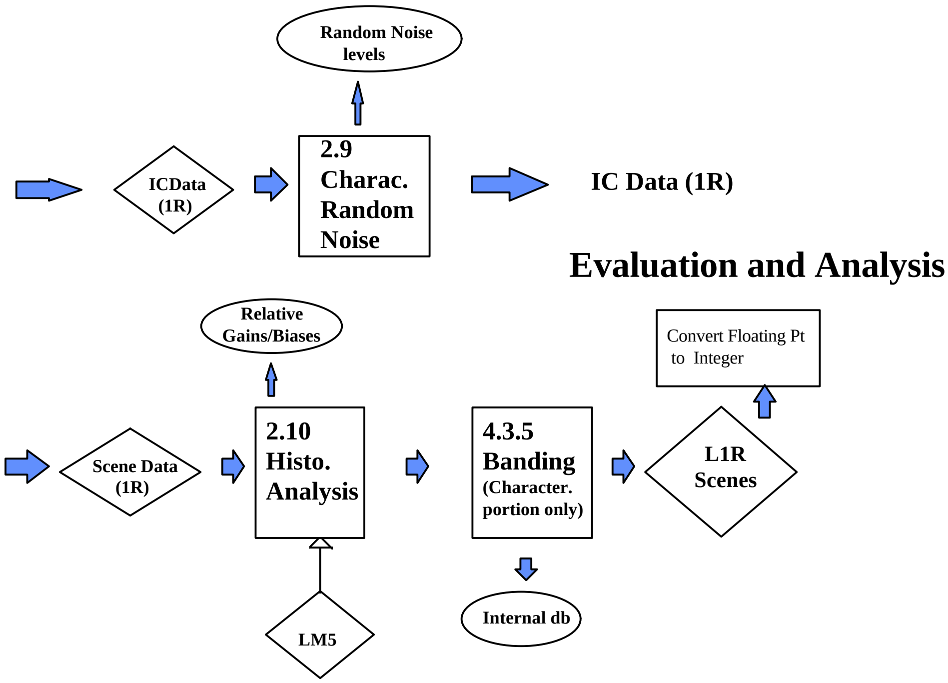


Process PASC

Step 4. 1R Correction

(revised 11/29/96 ssj)

REVIEW



Process PASC

Step 5. 1R Radiometric Characterization/Correction

(revised11/29/96 ssj)

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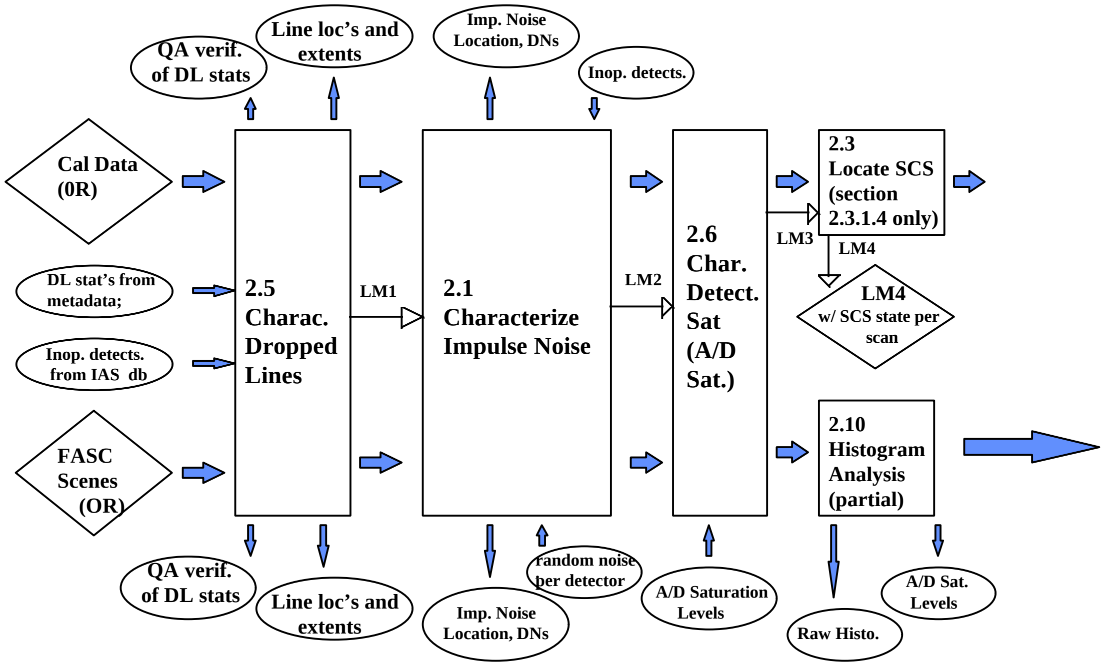


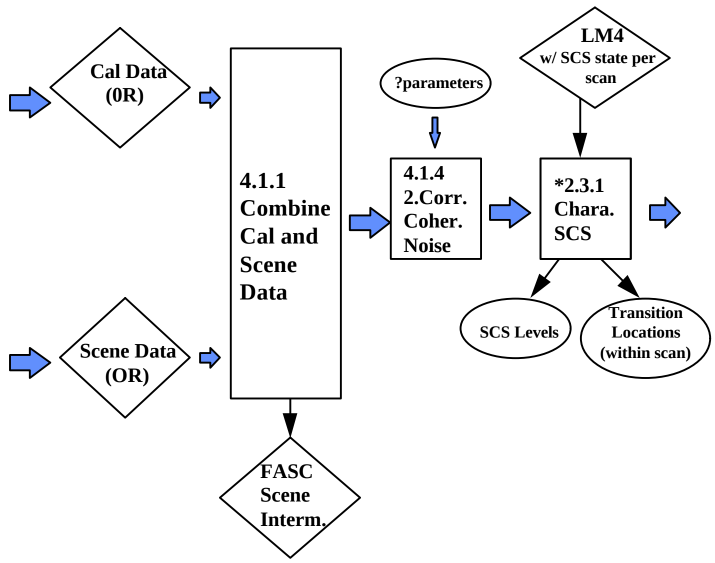
Process FASC

Step 1. 0R Radiometric Characterization

(update 11/29/96 ssj)

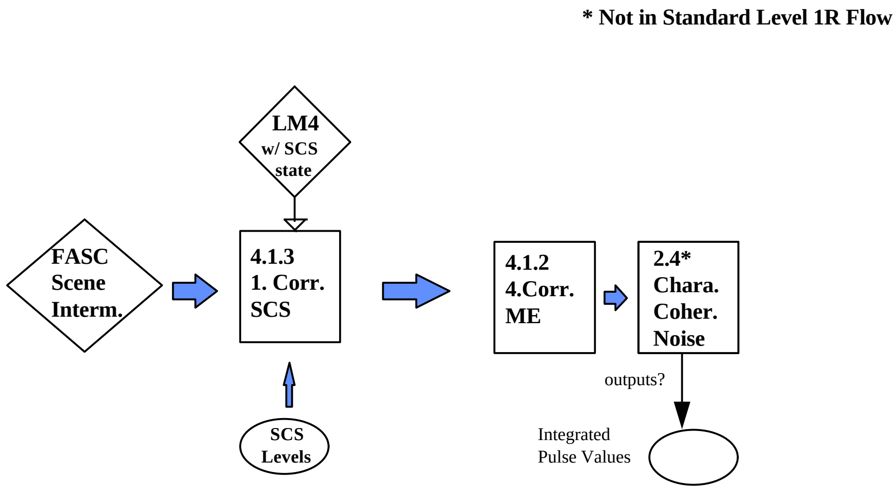
REVIEW

*** Not in Standard 1R processing**



Process FASC
Step 2. Scan Correlated Shift Characterization
(revised 11/29/96 ssj)

REVIEW

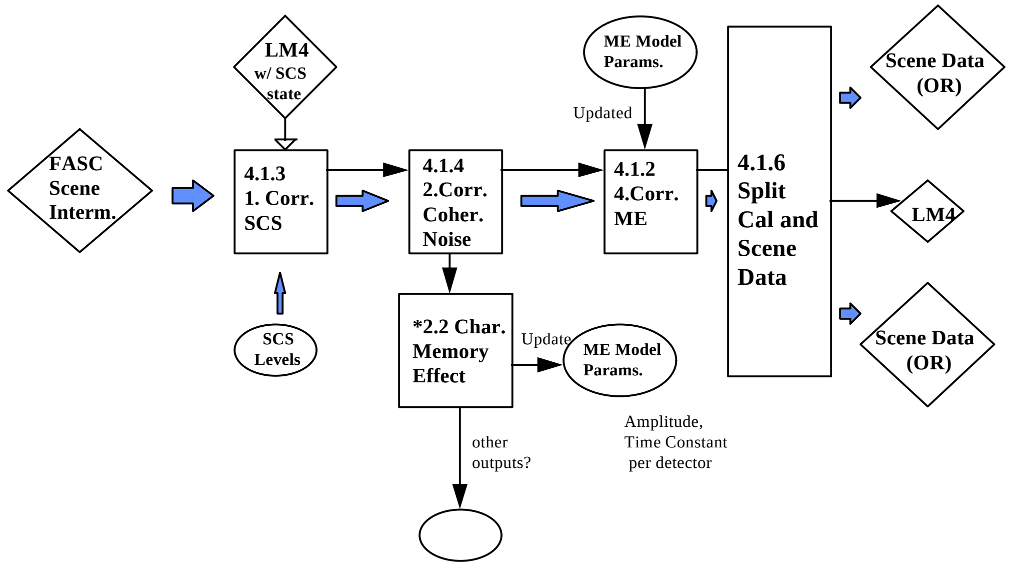


Process FASC

Step 3. Coherent Noise Characterization

(revised 11/29/96 ssj)

REVIEW



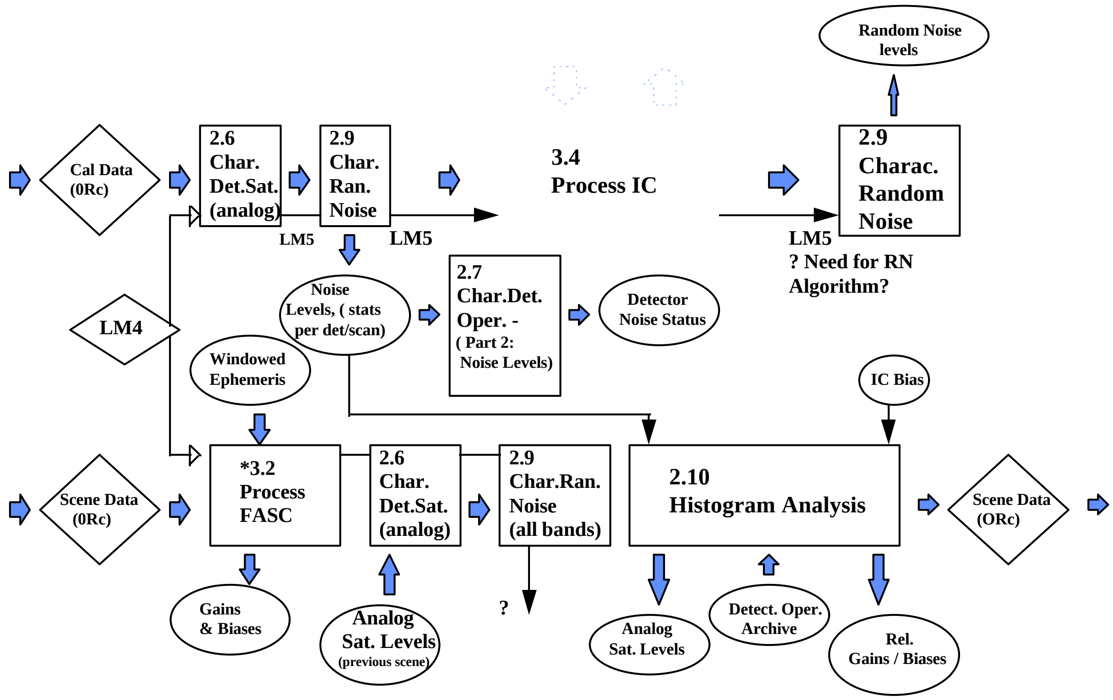
*** Not in Standard Level 1R Flow**
ME char. unique by source

Process FASC

Step 4. Memory Effect Characterization

(revised 11/29/96 ssj)

REVIEW

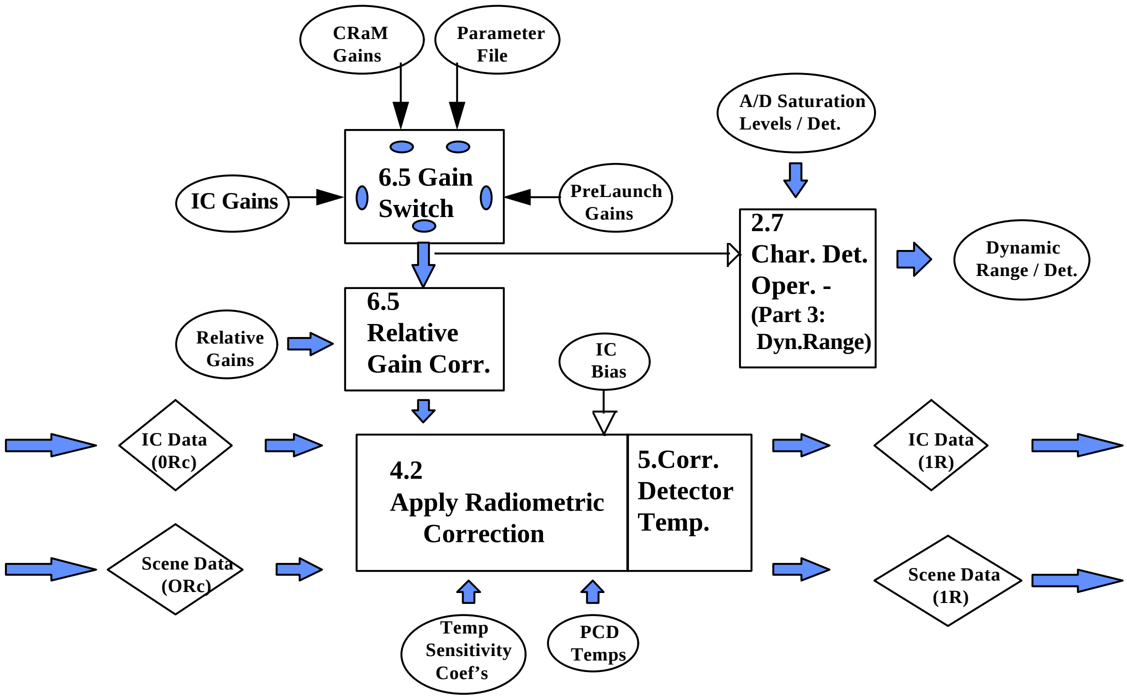


* Not in standard 1R Processing Flow

Process FASC

Step 5. Process FASC Data

(revised 11/29/96 ssj)

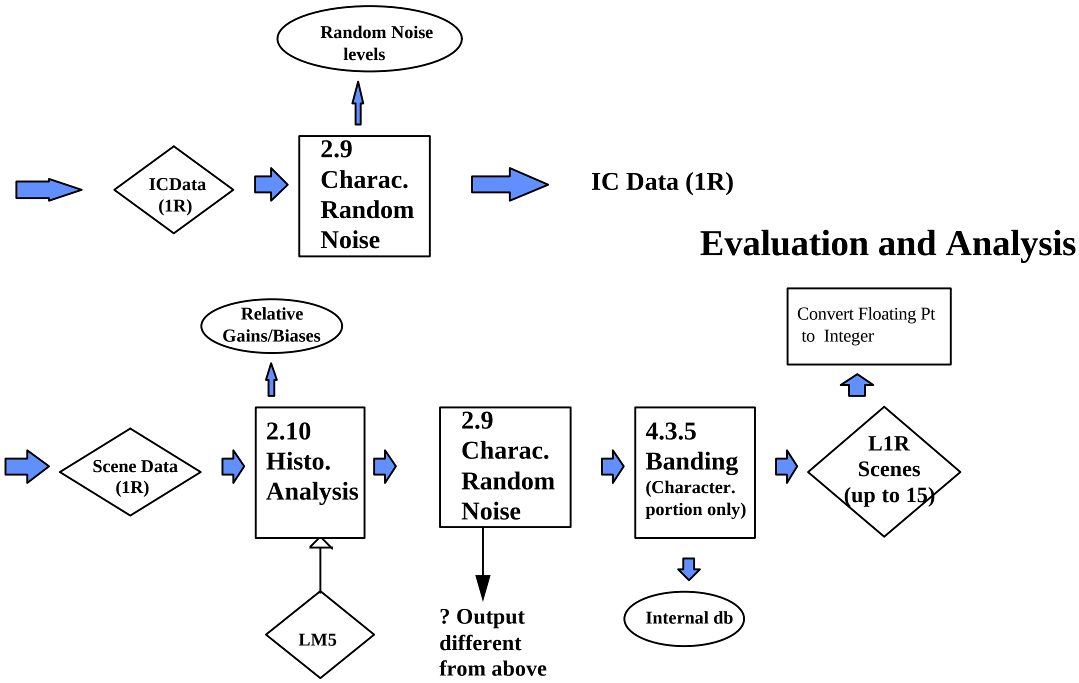


Process FASC

Step 6. 1R Correction

(revised 11/29/96 ssj)

REVIEW



Process FASC

Step 7. 1R Radiometric Characterization/Correction

(revised11/29/96 ssj)

Appendix D. IAS Database Table Definition Report.

The physical design of the database was generated from the entity relationship model (ERD) using the Oracle's Designer/2000 tool. The following table definition report, including the tables definitions, primary and foreign keys and sizing estimates were generated directly from Designer/2000 for this document.

The report consists of a column summary for all elements in the table, its primary key components, a description of any foreign keys and an index summary. The second part of this report for each table consists of the implementation details. The specified implementation details will be used when allocating the physical space for the table in the tablespace. The details includes the tablespace for the table, initial extent, next extent, percent increase and the minimum and maximum extents. It also consists of the estimated number of rows for each table over the life of the system, from the start to the end.

The report material from Designer/2000 is TBS.

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Appendix E. IAS Reports.

This Appendix presents the content of the reports produced by the IAS analyst for distribution to the MMO via the DAAC. The reports on the radiometric assessment and evaluation are TBS..

Appendix F. Database Sizing Formulas

This appendix presents the approach for estimating the space required to store the Table and Index database objects defined within the tablespaces. It also estimates the size of the indexes created implicitly, by the Primary Key / Unique Key definition on the tables. The names of these indexes are taken to be the same as the constraint names.

If any tables, indexes or constraints are not associated with a tablespace, the report assumes they will be created on the 'default' tablespace.

Table size estimates and index size estimates are done separately, as given in the *ORACLE7 Server Administrator's Guide*. Wherever PCTFREE, INITRANS parameters and other Storage parameters have not been defined, the default value is taken. The appendix does not include an estimate of the space required to store PL/SQL package codes, Snapshots or View definitions.

There are three size estimates:

- Start size -based on the 'start rows' defined for the tables, using column average lengths and percent used to calculate the rowsize
- End size -based on the 'end rows' defined for the tables, using column average lengths and percent used to calculate the rowsize
- Max size -based on the 'end rows' defined for the table, but assuming every column is maximum length and present in every row.

F.1 Table Size Estimate Methodology

To estimate Table Size, it is necessary to

- Estimate the Start/End the maximum rowsize
- Calculate the estimated data space available per block
- Use the resulting data to obtain the rounded table size

The following subsections provide the steps required to complete this estimate.

REVIEW

F.1.1 Estimate Start/End/Maximum Rowsize

The formula used to estimate the Row Size is as follows:

- For columns of type DATE, TIME, TIMESTAMP - start/end and maximum length is 7 bytes
- For columns of type ROWID - start/end and maximum length is 6 bytes
- For columns of type NUMBER, REAL, SMALLINT, DECIMAL, DOUBLE PRECISION, FLOAT, INTEGER, BINARY_INTEGER - (length/2 +1) rounded up to nearest integer.
- For start and end rowsize - average length is used. If average length is not specified, maximum length is used.
- For maximum rowsize, maximum length is used. If maximum length is null, a maximum length of 10 is assumed.
- For columns of type CHAR, the maximum length is used for start/end/maximum size. If maximum length is null, a length of 10 bytes is assumed.
- For ALL OTHER DATATYPES, the length is used.
- For start and end rowsize - average length is used. If average length is not specified, maximum length is used.
- For maximum rowsize, maximum length is used. If maximumlength is null, a maximum length of 10 is assumed.
- For start and end rowsize, the value calculated is then multiplied by the initial and end percent used respectively to give start and end bytes. (If either is not specified, 50% is assumed for NULL columns; 100% for NOT NULL)
- A column overhead of 1 byte per column is then added unless the calculated column length exceeds 250 bytes, when the row overhead is 3 bytes.
- These calculated values are listed for each column as start, end and maximum bytes when detail level is set to include columns.
- A row header of 3 bytes is then added to the total of all the column lengths to give the overall start/end/maximum rowsize.

F.1.2 Calculate Data Space Available per Block

To calculate the data space available per block, combine the following:

- Table Block Header = 61 + 23I + 2R where
  I = table inittrans
  R=no of rows

- Data Space = (B - Total Block Header) - (B - 57 - 23I)P/100 where
  B = blockizeand
  P=pctfree
  to give Data Space = (B-61-23I-2R) - (4+2R)P/100

F.1.3 Determine Estimated Table Size

The following defines the members of the formulas used in the calculations to determine estimated table size:

- No of rows per block = Data Space/rowsize rounded down to the nearest integer (unless this would give zero, when 1 is used)
- No of Blocks = No of Rows/No of Rows per
- Block = No of Rows * Rowsize / Data Space

The following calculations were used to obtain the size:

Table Size = No of Blocks * Blocksize
= No of Rows * Rowsize * Blocksize / Data Space
= R * rowsize * B / ((B-61-23I-2R) - (4+2R)P/100) where
R = No of Rows
B = blocksize
I = Inittrans
P = Pctfree

After the calculations were completed, the Table size is then rounded up to the nearest block (with a minimum of 2 blocks)

F.2 Index Sizes Estimate Methodology

To estimate Index sizes, it is necessary to

- Estimate the average entry size
- Calculate the data space available per each block
- Use the resulting data to obtain the rounded index size

The following subsections provide the steps required to complete the estimate for the Index sizes.

F.2.1 Estimate Entry Size

The formula used to estimate the Average Entry Size is as follows: Calculate start/end/max bytes per column exactly as for tables

- A column overhead of 1 byte per column is then added unless the calculated average column length exceeds 128 bytes, when the row overhead is 3 bytes.

- An entry header of 8 bytes is then added to the total of all the column lengths to give the overall entry size.

F.2.2 Calculate Data Space Available per Block

To calculate the data space available per block, combine the following two formulas:

- Index Block Header = 113 + 23I where
  I = index inittrans

- Data Space = (B - Block Header) - (B - Block Header)P/100 where
  B = blocksize and P = pctfree to give Data Space = (B-113-23I)(1-P/100)

F.2.3 Determine Index Sizes

The following defines the members of the formulas used in the calculations to determine estimated table size:

- No of entries per block = Data Space/(1.05*entry size) where the additional 5% is used for branch blocks of the index rounded down to the nearest integer (or 1 if this would result in zero)

- No of Blocks = No of Entries/No of entries per block = No of Entries * 1.05 * Entry size / Data Space

The following calculations were used to obtain the size:

- Index Size = No of Blocks * Blocksize
  = No of Entries * 1.05 * Entry size * Blocksize / Data Space
  = R * 1.05 * entry size * B * (1-P/100)/ (B-113-23I) where
  R = No of Rows in Table
  B = blocksize
  I = Inittrans
  P = Pctfree

- After the calculations were completed, the Index size is then rounded up to the nearest block (with a minimum of 2 blocks).

Note: The following default Values are assumed in the absence of supplied values :

Block Size	2048
INITRANS	1 for tables 2 for Indexes
PCTFREE	10

F.3 Storage Parameters

INITIAL EXTENT - if a specific initial extent has been requested, this is used otherwise, the initial table size is used. Initial extent is then rounded up to the next multiple of a blocksize

NEXT EXTENT if a specific next extent has been requested, this is used. Other wise, the initial tablesize is use Next extent is then rounded up to the next multiple of a blocksize

MINIMUM EXTENT - ((initial tablesize - initial extent)/initial) + 1 extent rounded up to nearest integer

MAXIMUM EXTENT - ((end tablesize - initial extent)/next extent) + 1 rounded up to nearest integer

%INCREASE - always set to zero

F.4 Notes

When the INITRANS and PCTFREE are set very high, the table will not be able to store any data rows, hence in such situations this report assumes the average rows per block to be 2048 bytes.

If no START ROWS and END ROWS are defined for a table or columns have not been defined, the minimum table size is assumed to be 2 blocks to account for the row headers and the block headers.

There may seem some discrepancy between the totals shown in the summary and the total of individual table/index sizes taken together. This is due to the fact that the rounding up of the bytes to KB or MB is done at the display time rather than at the calculation time. Note that all displayed values are rounded up to two decimal places, apart from the initial and next extent sizes which are rounded down to 2 decimal places (as Oracle automatically rounds these up to whole blocksizes on creation).